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INTRODUCTION

Research Program in Department of Agronomy

This report gives the research in progress in the Department of Agronomy. The purpose of the research program in the Department is to develop improved crop varieties and improved soil and crop management practices that result in more efficient crop production. Of equal importance is the development and application of principles of soil and water use and conservation. Investigations of the fundamental principles of genetics, physiology, and bio-chemistry of crops and the nature and properties of soils are major objectives of the Department of Agronomy. Results from the basic research are applied to the practical problems of agronomic nature.

The wide range of soils and 2.3 million acres of agronomic crops (corn, soybeans, tobacco, small grain, turfgrasses, hay, and pasture) grown in the state with a value of approximately 157 million dollars emphasize the size and importance of the research program in agronomy. To solve crops and soils problems research work is conducted at the University, on the University farms, and with cooperating farmers, golf course superintendents, and others throughout the state.

James R. Miller

Head, Department of Agronomy

Director, Maryland Agric. Expt. Sta.

Intra- and Inter-type Hybrids Among Burley, Flue-cured, and Maryland Tobaccos

M. K. Aycock, Jr.
Department of Agronomy

Purpose and Objectives

Heterosis has often been related to the degree of genetic diversity of the parents crossed. Hybrids among flue-cured varieties have shown very little heterosis for a number of agronomic and chemical characteristics while hybrids among Oriental varieties have given evidence of heterosis in excess of that normally found among flue-cured varieties.

Considerable data have been reported concerning interspecific hybrids. Heterosis estimates of 46 and 82% above the mid-parent value for yield and plant height, respectively, have been reported. Significant heterotic responses for inter-type hybrids involving Oriental and flue-cured varieties also have been reported.

The present study is being conducted in order to measure heterotic responses of intra- and inter-type hybrids involving burley, flue-cured and Maryland type tobaccos when grown in Maryland under Maryland cultural practices.

Procedures

In 1968 nine varieties (3 burley, 3 flue-cured, and 3 Maryland) and 36 F_1 hybrids (all possible hybrid combinations of the nine varieties excluding reciprocals) were grown in a field study at Upper Marlboro and Dentsville. A randomized complete block design was utilized with two replications at each location.

In the statistical analyses at each location, the hybrid sum of squares was partitioned into general combining ability (g.c.a.) and specific combining ability (s.c.a.) for each character.

Results

Mean performance for the nine varieties and 36 F_1 hybrids is shown in Table 1. To date the entry sum of squares in the general analysis of variance has not been partitioned for each agronomic character in the combined analysis in order to determine significance of various comparisons of interest. However general trends are evident. The performance of the Maryland varieties was better than the burley and flue-cured varieties. The hybrids were superior to the varieties in yield and quality at Upper Marlboro but not at Dentsville. Among the hybrids, the inter-types were superior to the intra-types for yield and quality at Upper Marlboro but not at Dentsville. Normally in intra-type tobacco hybrids, the F_1 performance is between the two parents and slightly better than the mid-parent value; however, in certain crosses of this study the F_1 was superior to the high parent. For example Catterton and Md. 59 yielded 1593 and 1588 pounds of cured leaf per acre, respectively, and the F_1 between these two varieties was 1766 pounds.

Estimates of general and specific combining ability variances are given in Table 2. Variance due to general combining ability appears to be of greater importance than specific combining ability. General combining ability was significant either at the 5% level or 1% level of probability for all agronomic characters while specific combining ability was significant for only one (Table 2). These results suggest that additive gene effects are more important than non-additive effects, and selection in segregating generations for improved pure lines is possible.

Summary

Small heterotic responses for yield and quality were observed particularly at the Upper Marlboro location. Among the hybrids, the inter-types were superior to the intra-types for yield and quality. Estimates

of general combining ability variance in these tobacco populations have been much larger than estimates of specific combining ability variances. These results suggest that additive genetic effects are more important than non-additive genetic effects. Therefore progress through selection in segregating populations could be made and superior pure line varieties developed.

Table 1. Performance of Maryland, burley, and flue-cured tobacco varieties and 36 intra- and inter-type F_1 hybrids grown at two locations, 1968.

	Yield per acre (lbs.)	Value		Plant height (cm)	Leaves per plant	Internode length (cm)	Days to flower	Total alkaloids (%)	Total nitrogen (%)	Duration of burn (sec.)	Filling capacity (cc/g)
		$/A	$/cwt								
Md. Varieties											
Catterton	1593	1063	66.79	79.0	16.7	4.75	48.0	2.15	2.04	3.4	6.30
Md. 59	1588	1098	69.30	77.6	14.7	5.32	51.0	2.20	2.36	6.8	5.60
Md. 64	2028	1229	61.07	69.8	17.2	4.12	53.0	1.89	2.56	3.9	5.68
Burley Varieties											
Bu. 21	1520	849	55.90	97.1	17.6	5.50	56.5	2.32	2.70	2.7	5.38
Bu. 49	1390	765	55.01	86.1	19.3	4.42	58.0	2.12	2.90	4.1	4.90
Ky. 12	1653	918	55.58	101.8	23.1	4.40	55.8	2.15	2.71	3.0	5.92
Flue-cured Varieties											
402	1323	845	63.76	83.2	14.2	5.88	50.0	2.18	2.34	3.6	5.78
NC 75	1583	962	60.79	102.3	15.6	6.50	55.2	2.21	2.40	5.5	5.80
NC 95	1283	763	59.37	85.3	16.6	5.18	51.0	1.99	1.92	3.4	6.60
Hybrids											
Catterton x Md. 59	1766	1223	69.33	86.0	17.7	4.88	49.5	2.02	2.06	5.7	6.15
x Md. 64	1858	1302	70.09	67.3	16.7	4.08	51.2	2.06	2.09	3.1	6.02
x Bu. 21	1688	1145	67.74	91.2	17.9	5.08	49.2	2.41	2.27	2.4	5.58
x Bu. 49	1648	1188	72.12	86.9	18.6	4.72	51.2	2.36	2.12	3.2	5.82
x Ky. 12	1766	1121	63.65	93.1	20.8	4.48	51.0	2.10	2.17	2.8	6.38
x 402	1615	1021	63.08	90.0	16.5	5.50	49.5	2.10	2.14	3.4	6.52
x NC 75	1736	1142	65.89	90.6	16.2	5.60	49.8	2.18	2.16	2.8	6.10
x NC 95	1568	1003	64.12	87.0	16.6	5.25	48.8	1.85	1.96	2.7	6.80

Table 1. Performance of Maryland, burley, and flue-cured tobacco varieties and 36 intra- and inter-type F_1 hybrids grown at two locations, 1968. (Continued)

	Yield per acre (lbs.)	Value $/A	Value $/cwt	Plant height (cm)	Leaves per plant	Internode length (cm)	Days to flower	Total alkaloids (%)	Total nitrogen (%)	Duration of burn (sec.)	Filling capacity (cc/g)
Hybrids											
Md. 59 x Md. 64	1995	1333	67.42	77.2	17.0	4.58	52.2	2.08	2.36	5.4	5.58
x Bu. 21	1713	1170	68.39	85.2	16.5	5.22	50.5	2.36	2.44	3.2	5.12
x Bu. 49	1694	1083	64.90	88.7	18.3	4.92	52.0	2.20	2.46	4.2	5.15
x Ky. 12	1808	1154	63.81	96.4	20.0	4.85	50.8	2.23	2.08	3.0	6.10
x 402	1649	1098	66.61	88.0	15.5	5.72	50.8	2.36	2.10	4.2	5.80
x NC 75	1722	1136	66.06	96.8	15.5	6.25	52.0	1.70	2.08	4.5	6.00
x NC 95	1602	1072	66.98	90.6	15.9	5.75	50.8	2.13	2.05	3.2	6.20
Md. 64 x Bu. 21	2069	1283	61.98	88.8	18.2	4.88	51.5	2.11	2.31	3.3	5.22
x Bu. 49	1804	1146	63.13	88.2	18.7	4.70	53.0	1.76	2.10	3.7	5.82
x Ky. 12	2068	1228	59.33	84.2	20.2	4.18	51.8	1.93	2.12	2.8	5.92
x 402	1906	1271	66.52	86.7	16.8	5.15	50.8	2.11	2.02	3.3	6.18
x NC 75	1989	1142	57.62	99.1	17.0	5.85	52.2	1.35	2.09	4.2	6.30
x NC 95	1803	1142	63.23	82.5	17.1	4.88	50.0	2.21	2.06	2.6	6.52
Bu. 21 x Bu. 49	1547	868	56.16	88.3	17.7	5.00	55.0	2.24	2.84	2.7	5.10
x Ky. 12	1480	832	56.20	96.9	21.0	4.62	56.5	2.06	2.50	2.2	5.90
x 402	1504	950	62.74	89.5	14.6	6.12	50.5	2.58	2.39	2.8	5.35
x NC 75	1765	1034	58.72	99.5	15.7	6.40	53.2	2.16	2.15	2.8	5.55
x NC 95	1475	918	62.24	87.0	16.3	5.38	49.5	2.14	2.10	2.7	6.08

Table 1. Performance of Maryland, burley, and flue-cured tobacco varieties and 36 intra- and inter-type F_1 hybrids grown at two locations, 1968. (Continued)

	Yield per acre (lbs.)	Value $/A	Value $/cwt	Plant height (cm)	Leaves per plant	Internode length (cm)	Days to flower	Total alkaloids (%)	Total nitrogen (%)	Duration of burn (sec.)	Filling capacity (cc/g)
Hybrids											
Bu. 49 x Ky. 12	1599	911	57.07	93.8	20.7	4.55	57.0	2.03	2.66	3.0	5.85
x 402	1587	930	60.14	91.3	16.4	5.58	51.5	2.36	2.40	3.8	5.62
x NC 75	1855	1192	64.16	91.7	16.9	5.45	52.8	2.26	2.15	3.4	5.60
x NC 95	1437	878	61.01	88.1	16.6	5.30	51.8	2.02	2.05	4.4	6.48
Ky. 12 x 402	1516	898	59.14	83.1	15.8	5.30	51.2	2.52	2.29	2.6	5.88
x NC 75	1723	994	57.35	96.4	17.6	5.45	55.2	1.96	2.20	2.4	6.62
x NC 95	1522	929	60.90	88.5	18.2	4.88	51.2	2.06	1.98	2.4	6.72
402 x NC 75	1549	974	63.02	93.5	15.1	6.20	51.8	2.14	1.88	4.1	6.00
x NC 95	1516	874	57.96	89.5	14.5	6.22	51.5	2.32	2.05	3.5	6.45
NC 75 x NC 95	1589	1058	66.34	94.3	15.8	5.98	53.0	2.16	2.02	2.6	6.78
Mean	1669	1047	62.73	88.8	17.2	5.22	52.0	2.13	2.24	3.4	5.94
L.S.D. (.05)	266	214	7.85	12.7	2.3	0.44	3.1	--	--	N.S.	--
(.01)	355	286	10.50	17.0	3.1	0.58	4.1	--	--	N.S.	--

Table 2. Mean squares of general and specific combining ability (g.c.a. and s.c.a.) for certain agronomic characteristics of intra- and inter-type tobacco hybrids, 1968.

Source of variation	Yield per acre	$/A	$/cwt	Plant height	Leaves per plant	Internode length	Days to flower
Hybrids	115,351**	76,017**	68.59*	149.62*	11.55**	1.45**	14.41**
g.c.a.	429,507**	269,956**	198.49*	349.56*	43.04**	5.78**	41.19**
s.c.a.	22,268	18,553	30.10	90.38	2.22	0.16*	6.48
H x L	35,639	23,315	32.66**	79.09	2.85	0.09	4.53**
g.c.a. x L	68,796*	28,035	44.52	88.54	4.69	0.10	7.22
s.c.a. x L	25,814	21,917	29.14**	76.29	2.30	0.08	3.73**

* Significant at the 5% level

** Significant at the 1% level

Performance of Breeding Lines in the Preliminary Variety Test, 1969

M. K. Aycock, Jr.
Department of Agronomy

Purpose and Objectives

The initial phase of a breeding program is developmental. Following a desired cross or series of crosses, selection for superior lines is conducted for a number of segregating generations. As new lines reach homozygosity information concerning agronomic and chemical performance is needed. The preliminary variety test is the initial screening process for new breeding lines. Superior breeding lines in this test are then included in the Official Variety Test for further evaluation.

Procedures

In 1968 a group of near homozygous lines with resistance to black shank and/or tobacco mosaic were selected from the tobacco breeding nursery for yield and quality evaluations. These breeding lines were tested in 1969 at Upper Marlboro.

Fourteen breeding lines and three standard varieties (Catterton, Md. 609, and Md. 64) were included in the test. The experimental design was a randomized complete block with three replications.

Results

The performance of 14 breeding lines and three standard varieties is shown in Table 1. M872 was the most outstanding breeding line in the test. It ranked second in yield and first in value per acre and value per hundredweight. This breeding line originated from a cross of Md. 609 x 41-2 (a Wilson-type breeding line). Considerable variation was observed among the other breeding lines and in comparison with the standard varieties. The top breeding lines from this test will be advanced to the Official Variety Test in 1970.

Summary

The performance of two breeding lines (M61 and M872) was very good when compared with the standard varieties. These two breeding lines will be advanced to the Official Variety Test in 1970.

Table 1. Performance of advanced breeding lines of Maryland tobacco in a preliminary variety trial at Upper Marlboro, Md., 1969.

Entry	Yield lbs/A.	Value $/A	Value $/cwt	Plant height (cm)	Leaves per plant	Internode length (cm.)	Days to flower	Total alkaloids (%)	Total nitrogen (%)	Duration of burn (sec.)
M61 *	1824	1349	73.97	75.4	20.2	3.77	57.3	1.56	2.31	5.2
M68	1559	1117	71.43	92.8	19.7	4.70	56.0	1.77	2.37	3.3
M73	1880	1312	69.96	94.5	21.0	4.50	55.0	0.94	2.08	8.2
M811	1804	1282	71.16	89.9	20.2	4.43	54.7	1.50	2.15	4.3
M812	1981	1277	64.26	82.5	21.0	3.93	57.0	1.14	2.31	3.2
M851	1880	1179	62.54	93.1	18.9	4.93	54.7	1.38	2.73	3.1
M852	1887	1167	62.06	87.8	19.6	4.43	55.7	1.30	2.51	5.8
M853	2010	1172	58.59	87.4	18.5	4.73	56.3	1.45	3.04	4.2
M872 *	2086	1609	77.13	85.1	18.4	4.60	55.3	1.48	2.50	4.1
M882	1766	1301	73.51	81.3	16.3	4.97	57.3	1.34	2.66	3.5
M901	1842	1244	67.68	92.1	19.4	4.77	59.3	1.64	2.93	7.6
M902	1788	1236	69.14	102.8	20.6	5.00	55.7	1.65	2.37	5.6
M911	1821	1174	64.93	91.5	18.5	4.93	55.0	1.23	1.84	7.5
M912	1736	1131	65.21	94.7	18.3	5.17	54.3	1.26	2.37	6.2
Catterton	1417	1024	72.18	83.2	18.8	4.50	48.3	1.45	1.89	2.9
Md. 609	1915	1436	74.88	93.8	20.8	4.53	57.3	1.63	2.10	7.6
Md. 64	2422	1589	65.85	84.7	22.0	3.83	54.3	1.53	2.43	3.8
Mean	1860	1270	68.50	89.0	19.5	4.57	55.5	1.43	2.39	5.1
L.S.D. (5%)	229	182	7.15	11.2	2.8	0.35	N.S.	N.S.	0.66	3.0
(1%)	308	245	9.63	15.1	3.8	0.47	N.S.	N.S.	N.S.	4.0
C.V. (%)	7.4	8.6	6.3	7.6	7.3	4.6	5.6	19.4	16.7	35.4

* Advanced to Variety Trials, 1970

Performance of Maryland Tobacco Varieties and Breeding Lines, 1968

M. K. Aycock, Jr.
Department of Agronomy

Purpose and Objectives

The Official Variety Test is the final phase of the breeding program and has three main objectives: (1) To obtain additional information on the varieties presently being grown by the majority of the tobacco farmers, (2) to evaluate advanced breeding lines which appear to have potential as a new variety, and (3) to provide a guide to southern Maryland tobacco farmers for use in choosing a variety to produce their best crop.

Procedures

Each year the variety tests are conducted at three locations with varying soil types. At Upper Marlboro, Davidsonville and Dentsville the tests are grown on Monmouth fine sandy loam, Galestown loamy sand and Beltsville silt loam soils, respectively.

The 1968 test which is included in the present report contained seven varieties and nine breeding lines. Eight breeding lines in the test were developed by the USDA at Beltsville under the direction of H. A. Skoog. M30 was an Agricultural Experiment Station entry.

Four replications of a randomized complete block design were used at each location. Each plot consisted of one row of 28 competitive plants. The plots were three feet apart and plants spaced two feet apart in the plot. Twenty-five competitive plants per plot were cut at harvest.

The various agronomic and chemical characteristics measured and methods of data collection have been outlined by Aycock et al., 1968, Md. Agr. Exp. Sta. Mis. Pub. 662.

Results

The average performance of the varieties and breeding lines compared at three locations in 1968 is shown in Table 1. Md. 64 was the highest yielding variety with 2051 pounds of cured leaf per acre; however, the quality of Md. 64 was significantly lower than Md. 609. The high yield and low quality of Md. 64 and the medium yield and top quality of Md. 609 resulted in similar dollars per acre for these two varieties.

The varieties ranged from 29.2 inches (Wilson) to 32.6 inches (Md. 10) in height. Considerable variation also was noted in the number of leaves per plant with Md. 59 having the fewest (17.0) and Md. 64 the greatest (20.1). The short height and high leaf count of Md. 64 produces a very compact plant often referred to as "thickset". This is evident when the internode lengths are considered since Md. 64 has the shortest internodes of the varieties tested.

The characteristic days to flower is used to measure maturity. It does not portray completely the time of maturity for all the varieties since the period of time from flowering to harvest may vary for the varieties; however, the earlier flowering varieties are generally harvested first. Each plot is then harvested at maturity. Factors which are considered in the determination of maturity are (1) the color of the plant from top to bottom, (2) the size of the upper leaves, (3) the brittleness of the leaves, and (4) the brittleness (woodiness) of the stalk. To harvest a test completely, usually two or three harvest dates are necessary. However in 1968 each location was harvested in one day or as close to one day as possible since all entries appeared to be in the same stage of maturity at the same time. Seasonal conditions, particularly the dry period in July, probably attributed to the similarity in maturity and

harvest dates. Gertz and Catterton were the earliest in flowering, 49.2 and 49.6 days, respectively (Table 1). Md. 64 is a slow growing, late maturing variety. It flowered 53.3 days after transplanting. Md. 609 required the same number of days to flower as did Md. 64, 53.4 days. Under normal conditions, Md. 609 and Md. 64 will remain in the field longer after flowering than Catterton.

In general the varieties were about average in chemical composition and filling capacity and all were within the range of acceptability.

J-67-122F-1, a Wilson-type breeding line, was the highest yielding line in the test with 2015 pounds of cured leaf per acre (Table 1). J-67-42F-1 was the highest quality line with an average of $70.30 per hundredweight. The combination of above average yield and good quality appears to exist in J-67-201F-1. These two characteristics caused this line to produce a value per acre of $1312, the highest in the test (Table 1). Additional years of testing are needed for this line since 1968 was the first year it had been in the variety test.

Considerable variation is present among the breeding lines for plant height. J-67-233F-1 and M30 averaged 36.5 inches and 35.7 inches, respectively, for plant height which is significantly taller than any of the standard varieties. Most of the breeding lines are about average for number of leaves per plant and internode length and were similar to the varieties.

Chemically, the breeding lines ranged from 1.90% to 3.08% in percentage of total alkaloids. M30 was significantly lower in total alkaloids than the lowest variety (Md. 64). The range for total nitrogen was not as great and all breeding lines were between 2.46% and 2.65%.

The ranges observed for days to flower, duration of burn and filling capacity for the breeding lines were similar to the ranges observed in the varieties for these same characteristics.

Summary

The variety testing program was conducted at three locations in 1968. Several breeding lines with multiple disease resistance appear to have real potential as new varieties. Evidence of this is the recent release of Md. 10, a mosaic resistant Catterton-type variety.

Table 1. Performance of Maryland tobacco varieties and breeding lines at three locations, 1968.

Variety or breeding line	Yield per acre (lbs.)	Value $/A	Value $/cwt	Plant height (in.)	Leaves per plant	Internode length (in.)	Days to flower	Total alkaloids (%)	Total nitrogen (%)	Duration of burn (sec.)	Filling capacity (cc/g)
Catterton	1576	1052	67.21	31.4	17.9	1.76	49.6	2.62	2.52	3.8	6.89
Wilson	1943	1131	58.75	29.2	18.1	1.62	51.1	2.41	2.50	4.0	6.32
Gertz	1700	1057	62.39	31.6	18.6	1.70	49.2	2.78	2.57	3.7	6.13
Md. 59	1712	1165	68.29	32.4	17.0	1.90	50.2	2.63	2.82	5.9	6.14
Md. 609	1759	1224	69.64	31.6	17.4	1.82	53.4	2.44	2.92	4.4	5.95
Md. 64	2051	1182	58.03	30.7	20.1	1.53	53.3	2.28	2.48	4.7	6.42
Md. 10	1641	1115	68.32	32.6	19.0	1.74	52.7	2.46	2.38	5.0	6.88
J-67-30F-1	1689	1181	69.88	30.7	17.0	1.81	51.1	3.04	2.58	2.6	6.12
J-67-42F-1	1710	1200	70.30	29.9	18.2	1.64	50.7	3.08	2.48	3.1	6.41
J-67-109F-1	1976	1244	63.05	30.6	18.1	1.69	53.1	2.29	2.65	3.9	6.49
J-67-111F-1	1852	1093	59.11	29.7	16.8	1.77	51.3	2.44	2.64	5.2	6.24
J-67-122F-1	2015	1138	57.00	30.5	17.2	1.77	51.5	2.36	2.59	5.3	6.14
J-67-228F-1	1676	1044	62.24	32.5	17.3	1.88	50.0	2.50	2.57	6.1	6.17
J-67-233F-1	1951	1253	64.72	36.5	19.8	1.85	57.6	2.31	2.50	6.8	6.43
J-67-201F-1	1931	1312	68.34	31.0	18.6	1.68	53.0	2.62	2.54	4.2	6.54
M30	1762	1074	61.07	35.7	19.2	1.85	52.7	1.90	2.46	6.0	6.90
Mean	1809	1154	64.27	31.7	18.2	1.75	51.9	2.51	2.57	4.7	6.38
L.S.D. (5%)	162	N.S.	5.30	2.8	1.2	0.12	2.2	0.37	N.S.	1.8	0.36
(1%)	218	N.S.	7.14	3.8	1.6	0.16	3.0	0.50	N.S.	2.4	0.49
C.V. (%)	7.4	8.2	5.7	7.6	6.6	4.3	2.1	16.9	11.5	43.4	5.5

Development of Improved Strains of Maryland Tobacco Resistant to Disease

M. K. Aycock, Jr.
Department of Agronomy

Purpose and Objectives

A number of diseases attack tobacco grown in southern Maryland; therefore, a large part of the breeding program at the University of Maryland is concerned with disease resistance. At the present time the tobacco mosaic virus appears to be the most destructive disease and until recently, none of the varieties being grown had mosaic resistance. However in 1969, Md. 10, a new Catterton-type mosaic resistant variety was released jointly by the U. S. Department of Agriculture and the Agricultural Experiment Station (Skoog, H. A. and M. K. Aycock, Jr. 1969. Agr. Exp. Sta. Mis. Pub. No. 734). Other diseases which cause some loss in Maryland tobacco each year are black root rot (Thielaviopsis basicola), wildfire (Pseudomonas tabaci), black shank (Phytophthora parasitica var. nicotianae), and fusarium wilt (Fusarium oxysporum var. nicotianae). At present the tobacco breeding program is concerned with developing varieties with resistance to two diseases -- tobacco mosaic and black shank.

Procedures

Breeding for Black Shank Resistance. The source of resistance to black shank presently being used is from Md. 59 and Md. 609 which are two varieties released in 1965. These two varieties were developed by Dr. O. D. Morgan, and the source of black shank resistance was from Florida 301.

During January and February, 1969 a modification of a black shank screening procedure utilized at the University of Kentucky was used to screen approximately 100 entries in the F_2 to F_7 generations. The pro-

cedure involved planting approximately 10 to 15 seeds of an entry in a vermiculite-filled 50 ml polypropylene centrifuge tube. About 4 weeks after seeding the seedlings were inoculated with the black shank fungus. Two weeks after inoculation the entries were scored on above ground plant parts (leaves and stems) and the roots. A scoring system of 0, 1, 2, 3 and 4 was utilized for the leaves and stems with a score of 0 representing no symptoms of the disease and a score of 4 representing complete death of all seedlings. A similar system was used for the roots symptoms with 0 representing no symptoms (roots white) and 4 representing severe browning of the entire root system.

Breeding for Mosaic Resistance. During December, 1968, 65 entries in the F_2 to the F_7 generations were screened for mosaic resistance. Each entry was represented by 10 plants. Seedlings which were approximately 2 months old were inoculated with the tobacco mosaic virus by rubbing the leaf with cheesecloth saturated in a solution of the virus. Approximately one week after inoculation, readings were made on the number of resistant and susceptible plants in each entry. At the time of scoring the resistant plants exhibited small necrotic spots at the cite of inoculation while the susceptible plants exhibited the characteristic mosaic pattern of dark and light green areas in the new growth. The necrotic spots of the resistant plants are due to a hypersensitive reaction of the leaf tissue to the virus. When the virus contacts the leaf cells, the cells die at such a rapid rate that the virus cannot spread.

Results

Black Shank Resistance. The results of the screening procedure for black shank resistance are presented in Figure 1. Considerable variation was found among the entries for black shank resistance. Some entries appeared to have complete resistance while others were completely susceptible.

From the leaf and stem scores, 58.5% of the entries received a score of 1.5 or better while 36.8% of the root scores fell within this same range. Entries with a score of 1.5 would probably have adequate resistance under field conditions in southern Maryland.

One reason for the wide variation among the entries for black shank resistance could be due to the nature of inheritance of the resistance. Resistance is believed to be dependent upon two major genes and several modifiers; therefore, through breeding the ultimate objective is to capture the two major genes and accumulate as many of the modifiers as possible.

Mosaic Resistance. The results of the tobacco mosaic screening procedure are shown in Figure 2. Resistance is determined by a single dominant gene; therefore, the plants fell into one of two classes -- resistant or susceptible. Approximately 97% of the entries were resistant. For the resistant entries, 14.3% appeared to be homozygous or true breeding and 85.7% were heterozygous or still segregating at the mosaic resistant locus.

Summary

Breeding lines with resistance to black shank and tobacco mosaic are being developed. Screening techniques which are relatively simple and reliable are being used in the greenhouse. Lines with good resistance based on greenhouse results were advanced an additional generation in the field nursery during the summer. Selection for plant type and other desirable agronomic traits was done in the field nursery.

Some of the breeding lines which have good resistance and desirable plant types have been observed in preliminary field trials under replicated conditions.

In 1969 a new Catterton type breeding line was released as Md. 10. This was a joint release by the Maryland Agricultural Experiment Station and the USDA, and is the first Maryland variety with mosaic resistance.

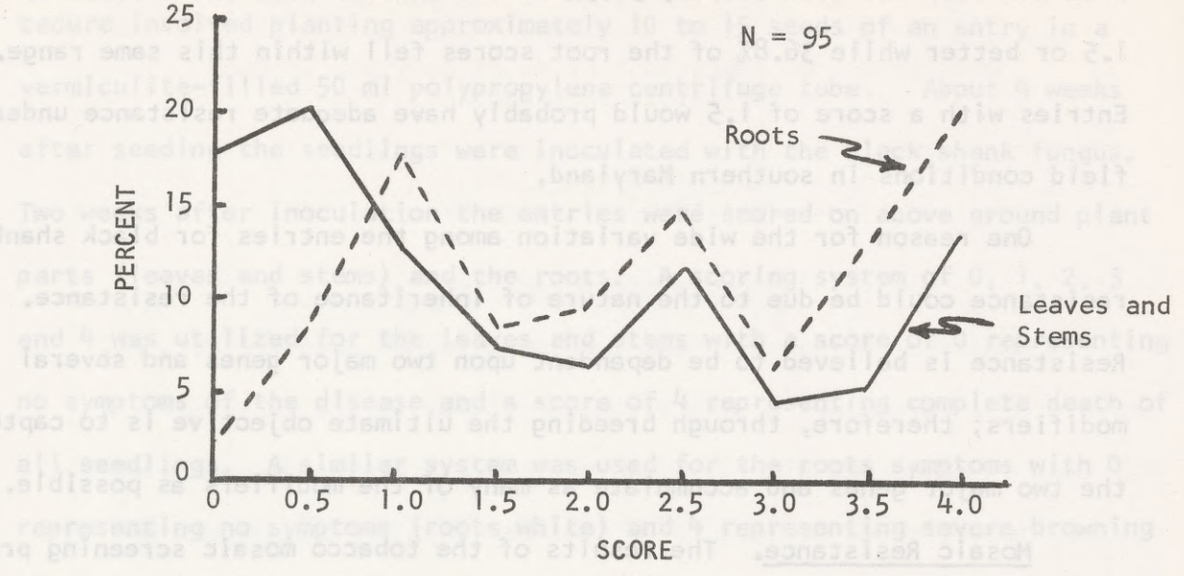


Figure 1. Frequency distribution of entries screened for black shank resistance; 0 = completely resistant and 4 = dead. (1969)

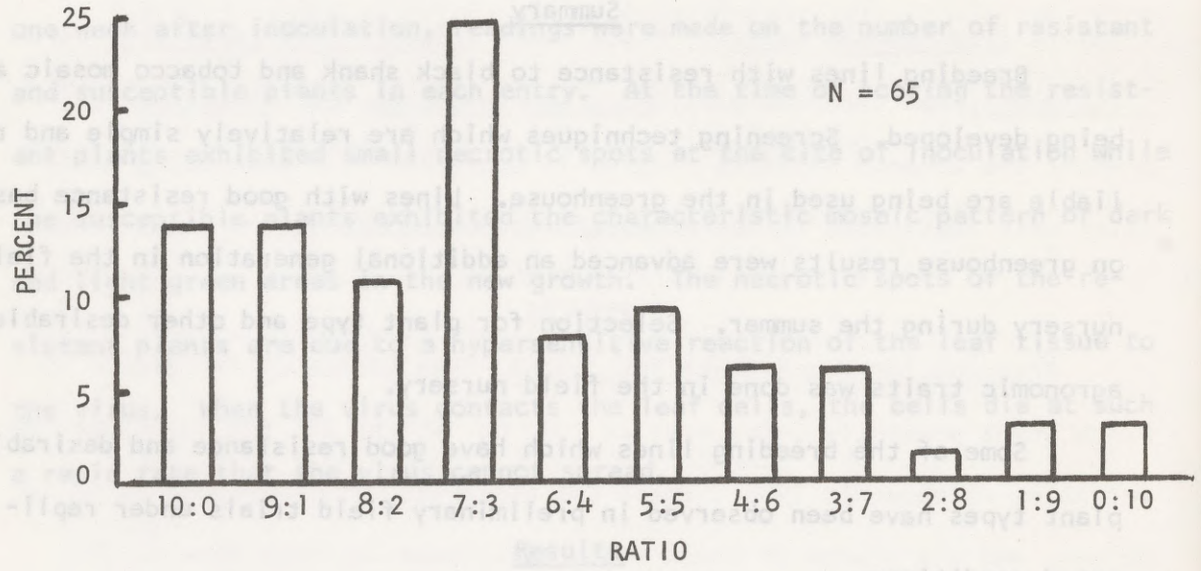


Figure 2. Frequency distribution of entries screened for tobacco mosaic resistance. The ratio is expressed as the number of resistant plants to the number of susceptible plants. (1969)

Heterosis in Maryland Tobacco

C. J. Fan and M. K. Aycock, Jr.
Department of Agronomy

Purpose and Objectives

F_1 hybrids are presently being grown on a commercial scale in a number of crops such as corn, sorghum, onions and burley tobacco. Success with hybrids in these crops is possible because (1) the hybrid is superior to the standard variety in one or more traits, and (2) an economical method of seed production is available. With the successful production of burley hybrids considerable interest has developed in Maryland as to the potential of hybrids. Therefore this study was undertaken in 1967 to determine the amount of hybrid vigor present in Maryland tobacco hybrids, and to gain some understanding of the genetic variances present in Maryland tobacco populations.

Procedures

In 1967 five varieties and 10 F_1 hybrids (all possible hybrid combinations of the five varieties excluding reciprocals) were grown in a field study at Upper Marlboro and Davidsonville. A split-plot design was utilized with three replications at each location. A family was considered the whole-plot and it contained one hybrid and its two parents for a total of three sub-plots per whole-plot.

This study was expanded in 1968 to seven varieties and 21 F_1 hybrids. These varieties and F_1 hybrids were grown in field trials at the same two locations. The experimental design was the same as that used in 1967 except two replications were utilized at each location.

Results

The results completed to date for 1968 are shown in Tables 1 and 2. The hybrids yielded more cured leaf per acre than the parents (varieties) at Davidsonville. At both locations the hybrids had a higher value per acre and value per hundredweight and were earlier flowering than the parents. The hybrids also had a lower content of total nitrogen than the parents at Upper Marlboro. No differences were noted for plant height, leaves per plant, total alkaloids, duration of burn, and filling capacity.

When a heterotic response is observed for an agronomic character in the F_1, the effects of inbreeding, or advancing the F_1 to the F_2, is of interest. The results from inbreeding will generally be the reverse of those observed in the F_1 hybrids, and give added support to the genetic variance estimates found in the F_1's. The effects of inbreeding are shown in Table 2. A reduction in value per acre and value per hundredweight were noted when the F_1 hybrids were advanced to the F_2. The F_2 generation also was longer in flowering than the F_1. These results with inbreeding are in general agreement with those found with hybridization, that is, the heterotic response observed in the F_1 is lost with inbreeding one generation.

Summary

F_1 hybrids exhibited better quality (as measured by dollars per hundredweight) and higher dollar return per acre than the varieties. The hybrids also were slightly earlier in flowering than the varieties. Advancing the F_1 hybrids to the F_2 generation resulted in a decrease in dollar per hundredweight and dollar per acre. Inbreeding breeding depression also was noted by latter flowering in the F_2 generation.

Table 1. Performance of seven varieties and 21 hybrids of Maryland tobacco grown at two locations, 1968.

Parent or F_1 hybrid	Yield per acre (lbs.)	Value		Plant height (cm)	Leaves per plant	Days to flower	Total alkaloids (%)	Total nitrogen (%)	Duration of burn (sec.)	Filling capacity (cc/5g)
		$/A	$/cwt							
Upper Marlboro										
Parental mean	1726	1247	72.48	72.6	15.6	47.5	1.91	2.15	4.03	29.95
F_1 hybrids	1771	1319	74.52	74.3	15.6	46.6	1.88	2.07	3.71	29.23
Parents vs. F_1's	NS	**	**	NS	NS	**	NS	*	NS	NS
Davidsonville										
Parental mean	1690	1100	65.26	74.8	17.8	51.8	2.00	2.73	8.50	26.75
F_1 hybrids	1780	1195	67.16	76.8	18.0	51.0	1.95	2.65	8.06	27.00
Parents vs. F_1's	**	**	**	NS	NS	**	NS	NS	NS	NS

NS Non-significance

* Significant at the 5% level

** Significant at the 1% level

Table 2. Performance of 10 F_1 and F_2 progenies of Maryland tobacco hybrids, 1968.

Progeny	Yield per acre (lbs.)	Value		Plant height (cm)	Leaves per plant	Days to flower	Total alkaloids (%)	Total nitrogen (%)	Duration of burn (sec.)	Filling capacity (cc/5g)
		$/A	$/cwt							
F_1	1891	1254	66.39	93.4	20.4	50.9	1.80	1.96	9.35	30.33
F_2	1849	1160	62.94	92.0	20.1	52.4	1.82	2.03	9.47	30.00
F_1 vs. F_2	NS	*	**	NS	NS	**	NS	NS	NS	NS

NS Non-significance

* Significant at the 5% level

** Significant at the 1% level

Johnsongrass Ontogony Under Three Controlled Temperature Conditions

G. W. Burt
Department of Agronomy

Purpose and Objectives

Johnsongrass (Sorghum halepense L. Pers.) has proven to be a very difficult weed to control. Several workers have reported experiments where up to 95% control has been achieved. However, when the remaining 5% can produce up to 212 feet of rhizomes the following year, this 5% represents a very serious problem. Chemical control measures have been published by several workers. When johnsongrass has been collected from several areas and given the identical treatments, the resulting control has varied from as high as 90% down to 45%. These wide differences in control are partly attributed to different johnsongrass selections exhibiting different degrees of tolerance to chemical treatments. To date these selections have been chosen on a location basis as only limited morphological differences have been detected. New control measures may be more easily developed if differential growth patterns can be identified and their mechanisms understood. This study was undertaken to further investigate potential differences in johnsongrass and possible control recommendations based on plant location.

Procedures

Three selections of johnsongrass were obtained from three locations representing different climatic conditions. These rhizomes were bulked in flats filled with vermiculite in the greenhouse. The three selections were representative of a cool region near Hagerstown, Maryland; a warm, intermediate region near Princess Anne, Maryland; and a warmer, southern region near Stoneville, Mississippi. Hereafter these selections will be designated as "N", "NS" and "S" respectively. Rhizome sections, all two

nodes long, were planted in vermiculite in 6 by 6 inch plastic pots. The pots within each of the three temperature treatments (20^{o}, 25^{o}, 30^{o}C) were randomly assigned to the controlled temperature chambers. All treatments received a 12 hour photoperiod. The pots were fertilized weekly with a Hoagland's nutrient solution at four times the normal concentration with low nitrogen and watered as required. The time taken for the rhizomes to grow shoots visible on top of the vermuculite was noted. In addition weekly measurements of the number of leaves and stems as well as the height to the highest node were taken. At the conclusion of the experiment, the final root, rhizome and total shoot weights were taken. A 3 x 3 factorial analysis was used to determine statistical differences between the treatments. Where main effects or interactions were significant, Duncan's New Multiple Range Test was used to determine specific statistical differences.

Results

Various differences were recorded among the three selections at the different temperatures. The NS selection at 30C was the tallest of the treatments while the N at 20C was the shortest growing selection. All the remaining treatments were the same height. However in total leaf production, shown in Figure 1, the N selection at 30C yielded more leaves than the other treatments. There was a direct correlation between temperature and leaf production. When the temperature rose, the number of leaves produced per selection rose also. Figure 2 shows the final rhizome weight of the three selections at the three temperatures. The S selection at 30C produced more rhizomes than all other treatments.

As the temperature rose, the stem production rose also. The highest temperature yielded the most stems. Similarly, the S selection produced the most stems. Although the stem number was statistically different from the NS selection, it did yield the same number of stems as the N selection.

As well as producing the most stems and rhizomes, the S selection also produced the highest total weight.

Summary

Although the NS selection grew taller than the other treatments, it produced the least rhizome growth. Therefore, in this experiment, the NS selection expanded more energy into producing high, long stems than it did for leaves and rhizomes. The S selection put most of its energy into above and below ground stems rather than in producing tall leafy plants; it was also the selection which produced the most total weight. In all cases the highest treatment temperature yielded the greatest growth. However, the selection which did best depended on the particular plant morphological characteristic being measured. The N selection came from a northern area where the parent rhizome would experience the coolest weather of the three selections. The N selection was not however, a superior producer of overall growth under the cooler treatment conditions.

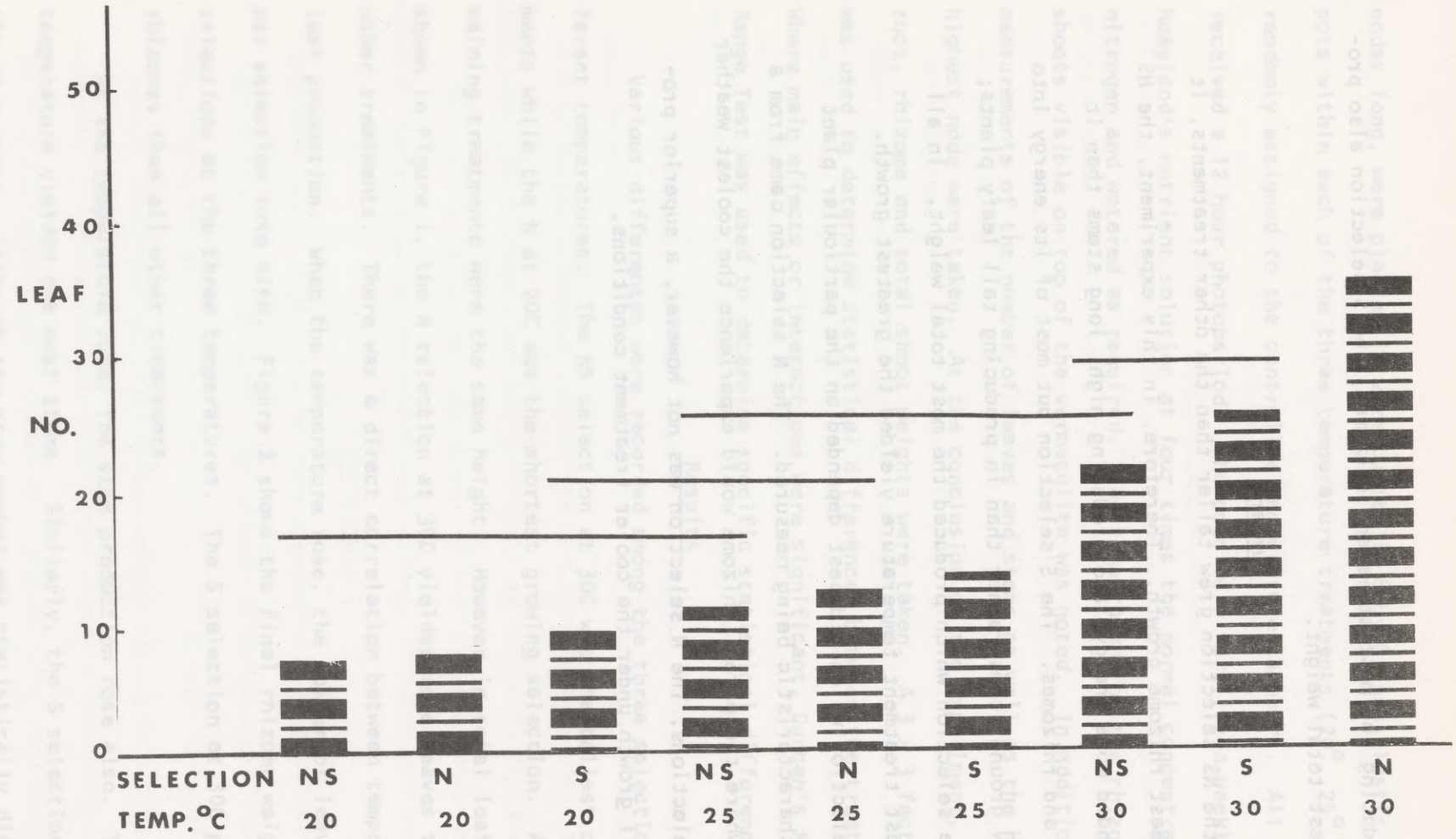


Figure 1. Number of leaves produced by the 3 selections at 3 temperatures.

All values are treatment means. Means underlined indicate non-significance at the 5% level of Duncan's New Multiple Range Test.

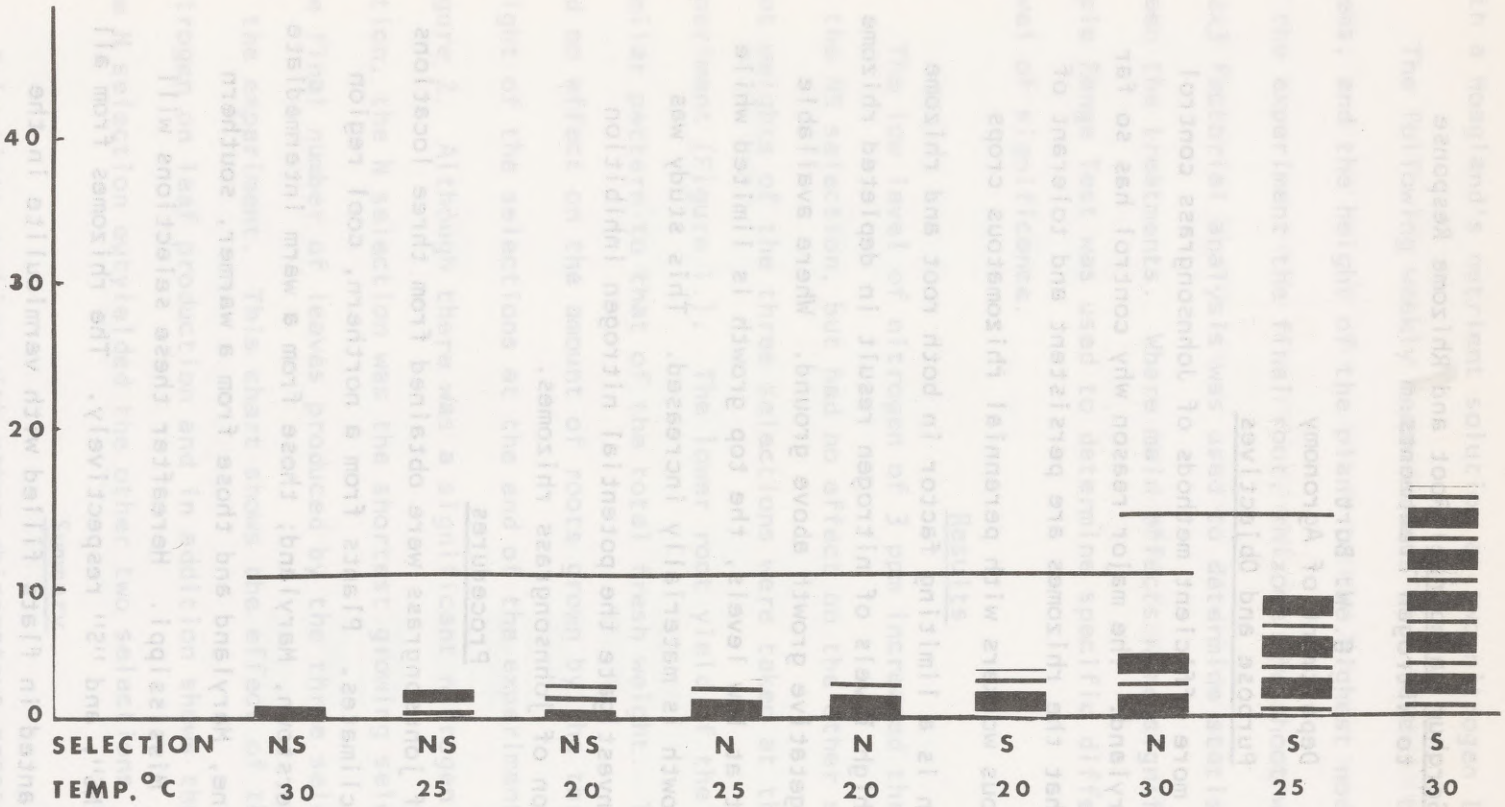


Figure 2. Rhizome weight of the 3 selections at the 3 temperatures.

All values are treatment means. Means underlined indicate non-significance at the 5% level of Duncan's New Multiple Range Test.

Johnsongrass (*Sorghum halepense*) Root and Rhizome Response to Nitrogen Treatments.

G. W. Burt
Department of Agronomy

Purpose and Objectives

The development of more efficient methods of Johnsongrass control is an urgent need in Maryland. The major reason why control has so far proven ineffective is that the rhizomes are persistent and tolerant of most treatments. Previous workers with perennial rhizomatous crops have noted that nitrogen is a limiting factor in both root and rhizome growth. In some cases high levels of nitrogen result in depleted rhizome growth and increased vegetative growth above ground. Where available nitrogen is present, but at low levels, the top growth is limited while the root and rhizome growth is materially increased. This study was undertaken to further investigate the potential nitrogen inhibition effects on the production of johnsongrass rhizomes.

Procedures

Three selections of johnsongrass were obtained from three locations representing different climates. Plants from a northern, cool region were collected near Hagerstown, Maryland; those from a warm intermediate region near Princess Anne, Maryland and those from a warmer, southern region near Stoneville, Mississippi. Hereafter these selections will be designated as "N", "NS", and "S" respectively. The rhizomes from all three locations were planted in flats filled with vermiculite in the greenhouse and allowed to grow new rhizomes. The new rhizome growth was cut into sections approximately 3 cm long and with a minimum of three nodes and planted in 6" x 6" diameter plastic pots in the greenhouse. The three selections were replicated 5 times, and grown to maturity in a randomized complete block design. The two treatments comprised weekly fertilization

with a Hoagland's nutrient solution at two nitrogen levels (3 and 30 ppm).

The following weekly measurements were taken: the number of leaves and stems, and the height of the plant to the highest node. At the conclusion of the experiment the final root, rhizome and shoot weights were recorded. A 2x3 factorial analysis was used to determine statistical differences between the treatments. Where main effects were significant, Duncan's Multiple Range Test was used to determine specific differences at the 5% level of significance.

Results

The low level of nitrogen of 3 ppm increased the yield of rhizomes in the NS selection, but had no effect on the other selections. The fresh root weights of the three selections were taken at the termination of the experiment (Figure 1.). The lower root yield of the N selection followed a similar pattern to that of the total fresh weight. The level of nitrogen had no effect on the amount of roots grown by the three selections. The height of the selections at the end of the experiment are presented in Figure 2. Although there was a significant nitrogen x selection interaction, the N selection was the shortest growing selection. Figure 3 shows the final number of leaves produced by the three selections at the termination of the experiment. This chart shows the effect of the 30 ppm level of nitrogen on leaf production and in addition shows the only occasion where the N selection outyielded the other two selections in this experiment.

Summary

Scientists working with other rhizomatous grasses have frequently found that at a low level of nitrogen, top growth is reduced while the root and rhizome production is increased. In this experiment only with the NS selection at the 3 ppm nitrogen concentration was there an increase in rhizome/root production and this did not appear to be at the expense of top

growth. In all other treatments nitrogen was not a limiting factor.

The N selection under these treatments was a rapidly maturing, short growing plant with a larger number of leaves than the other two selections. Although the S selection produced less leaves, it and the NS produced a higher total fresh weight than the N selection.

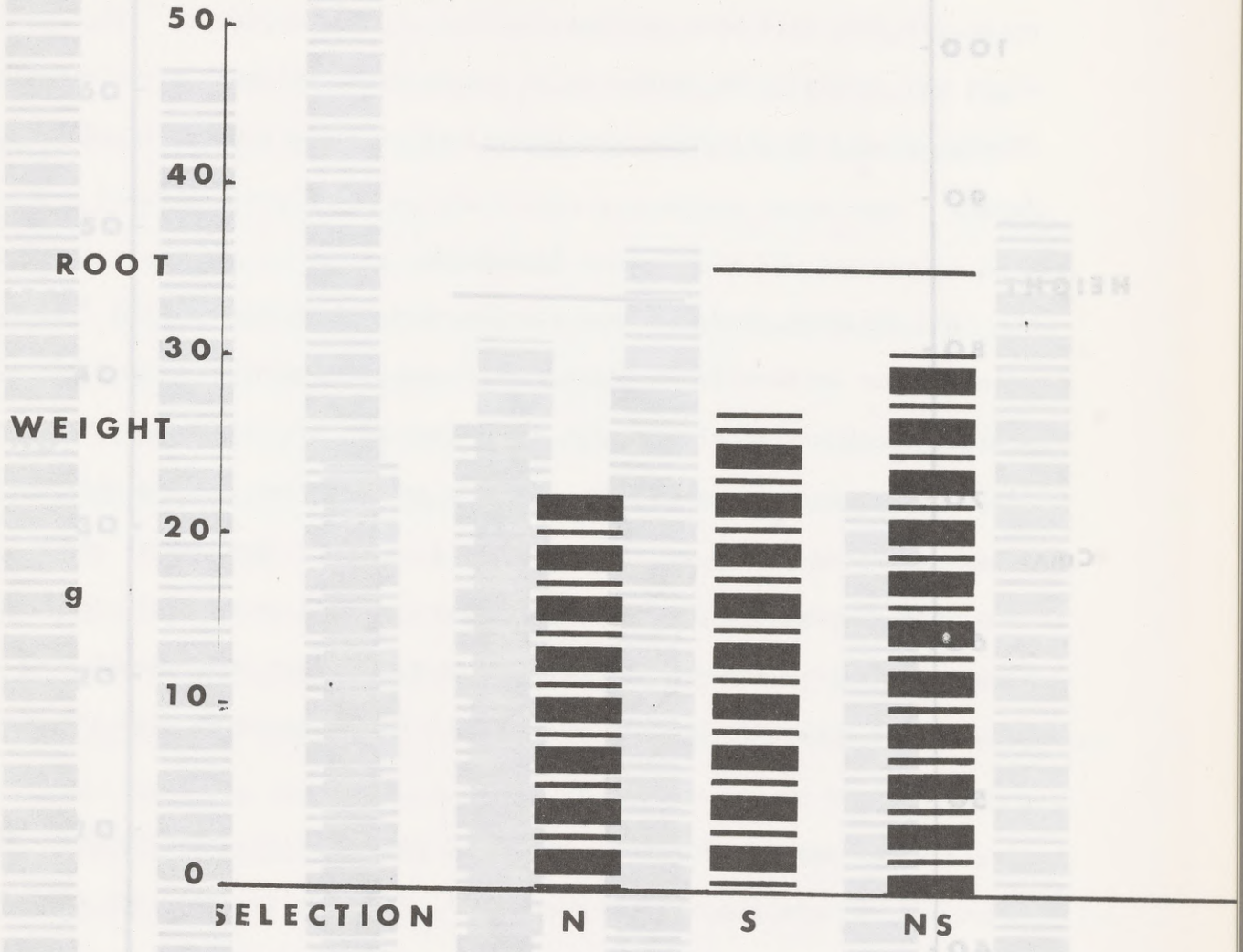


Figure 1. Root Weight of the 3 Selections.

All values are treatment means. Means underlined indicate non-significance at the 5% level of Duncan's New Multiple Range Test.

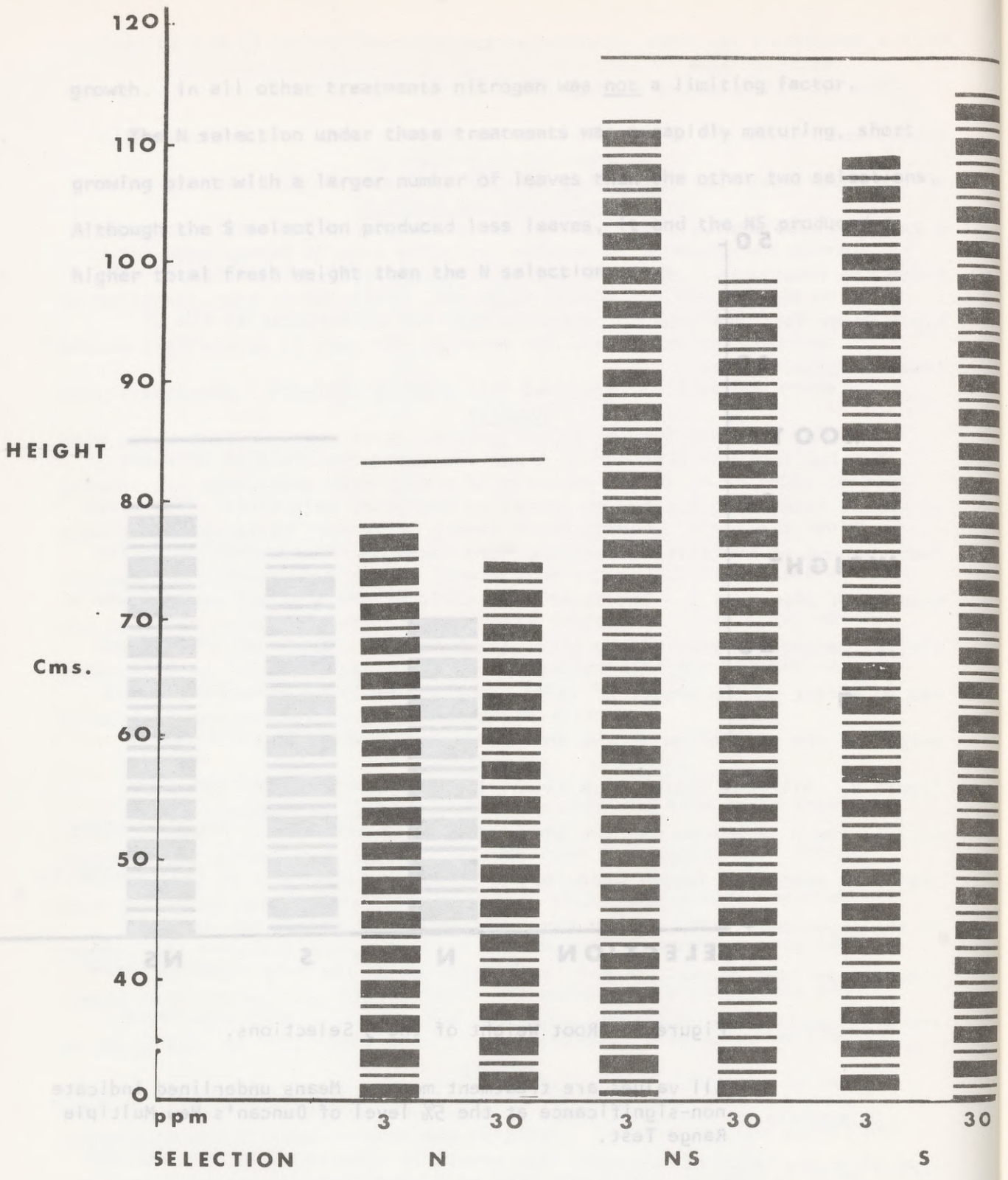


Figure 2. Height response to the selection x nitrogen interaction.

All values are treatment means. Means underlined indicate non-significance at the 5% level of Duncan's New Multiple Range Test.

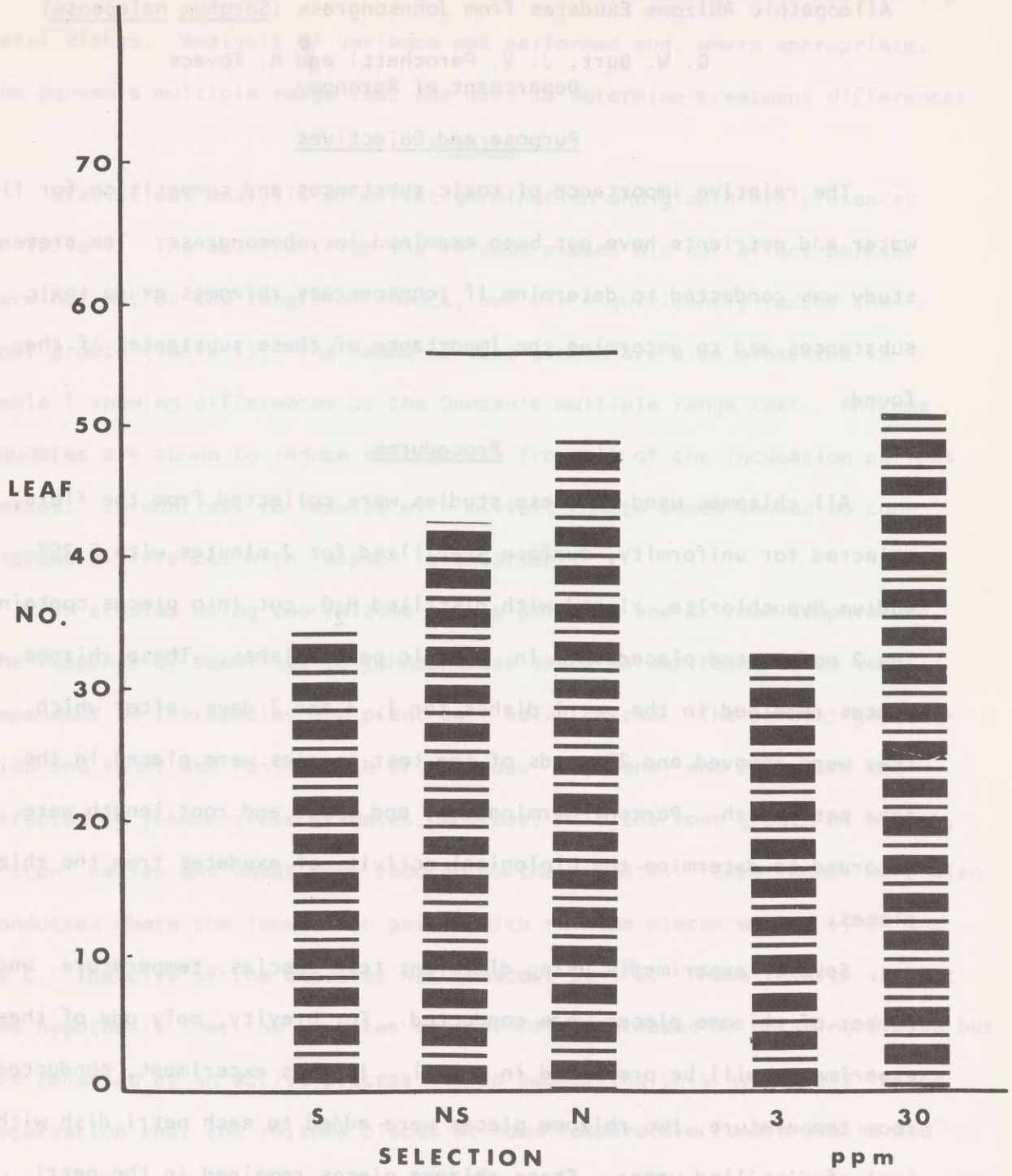


Figure 3. Leaf Production of 1). the 3 selection and 2). at the 2 levels of nitrogen.

All values are treatment means. Means underlined indicate non-significance at the 5% level of Duncan's New Multiple Range Test.

Alleopathic Rhizome Exudates from Johnsongrass (*Sorghum halepense*)

G. W. Burt, J. V. Parochetti and M. Kovacs
Department of Agronomy

Purpose and Objectives

The relative importance of toxic substances and competition for light, water and nutrients have not been examined in johnsongrass. The present study was conducted to determine if johnsongrass rhizomes exude toxic substances and to determine the importance of these substances if they are found.

Procedures

All rhizomes used in these studies were collected from the field, selected for uniformity, surface sterilized for 2 minutes with 5.25% sodium hypochlorite, rinsed with distilled H_2O, cut into pieces containing 2 nodes, and placed in 7 in. plastic petri dishes. These rhizome pieces remained in the petri dishes for 1, 3 and 7 days, after which they were removed and 20 seeds of the test species were placed in the same petri dish. Percent germination, and shoot and root length were recorded to determine the biological activity of exudates from the rhizome pieces.

Several experiments using different test species, temperature, and number of rhizome pieces were conducted. For brevity, only one of these experiments will be presented in detail. In this experiment, conducted at room temperature, two rhizome pieces were added to each petri dish with 6 ml of distilled water. These rhizome pieces remained in the petri dishes for 1, 3, and 7 days incubation period after which 20 seeds of tomato and millet were added. Each treatment was replicated three times and placed in a completely randomized design. Three replications of a control were included for each of the three incubation periods. Data for millet and

tomato was recorded at 4 and 7 days respectively, after placing seed in the petri dishes. Analysis of variance was performed and, where appropriate, the Duncan's multiple range test was used to determine treatment differences.

Results

Statistical analysis of millet germination and growth are presented in Table 1. The exudates from the rhizome pieces did not affect percent germination, or the length of shoots, but did significantly reduce the root growth (Table 1). The means of root growth are also presented in Table 1 showing differences by the Duncan's multiple range test. Rhizome exudates are shown to reduce root growth from all of the incubation periods tested. In contrast to results with millet, tomato seeds showed no consistent differences with respect to treatment.

In studies using two rhizome pieces per dish and at room temperature, the response of seedlings to johnsongrass exudates was found to be very dependent on the species and plant part being tested. The percent germination and shoot and root growth of tomatoes, soybeans, and corn were not affected by johnsongrass exudates, whereas, only the root growth of millet, cotton, barley and wheat were reduced by the exudates. Experiments were also conducted where the incubation period with rhizome pieces was at 5, 24 and 30°C. Toxicity of the exudates was greatest at 5°C. These results support the hypothesis that the exudates are not being released by decaying tissue but are released by an active process. Also supporting this hypothesis is the observation that the rhizome pieces at room temperature remain viable and often begin to grow during the incubation period. Experiments have also been conducted using 10 instead of 2 rhizome pieces per petri dish. These results support the observations at the lower density of rhizomes.

Summary

Experiments were conducted to determine if alleopathic substances are exudated from johnsongrass rhizomes. Johnsongrass rhizome pieces were placed in petri dishes for 1, 3, and 7 days after which the percent germination, and root and shoot growth were recorded for different test species. Results indicate that johnsongrass exudates alleopathic substances which reduce root growth of millet, cotton, barley and wheat but which do not effect the growth of tomatoes, soybeans, or corn.

Table 1. Statistical analysis of the influence of Johnsongrass exudates on millet germination and growth.

	Source of Variation	df	ms	f
	Total	17	91.6	7.44*
Root growth	Treatment	5	235.6	
	Error	12	31.7	
	Total	17	127.4	3.15
Shoot growth	Treatment	5	245.8	
	Error	12	78.0	
	Total	17	35.3	1.19
% Germination	Treatment	5	39.8	
	Error	12	33.4	

Duncan's multiple range test on root growth means (means underlined indicates non-significance).

Treatment (Number=days of incubation; C=control)	4	1	8	4C	8C	1C
mean (millimeters)	98	99	133	144	155	157

Differential Response of Johnsongrass (*Sorghum halepense*) to Dalapon (2,2-dichloropropionic acid)

G. W. Burt, J. V. Parochetti and I.M. Wedderspoon
Department of Agronomy

Purpose and Objectives

The spread of johnsongrass can be most successfully controlled by the use of both chemical and cultural methods. These control measures are not entirely adequate however because of wide variability in results. The experiments reported here were conducted to determine the influence of dalapon on the ontogeny of johnsongrass and the differential response of 3 selections of johnsongrass to dalapon.

Procedures

Three selections of johnsongrass were obtained from three locations representing different climates. Plants from a northern, cool region were collected near Hagerstown, Maryland; those from a warm intermediate region near Princess Anne, Maryland and those from a warmer, southern region near Stoneville, Mississippi. Hereafter these selections will be designated "N", "NS", and "S" respectively. These selections were used for 2 experiments where different amounts of dalapon were sprayed on the 3 selections grown in pots in the greenhouse. For brevity, only 1 of 2 similar experiments which were conducted is presented here. In June, 1969, 210 - 6-inch diameter pots were filled with vermiculite and a rhizome section at least 3 nodes long was placed in each pot. The 70 pots with each selection were placed in a randomized complete block design. Emergence dates were recorded and analyzed statistically. When the plants had from 5 to 7 leaves, the most uniform plants were selected and placed in a randomized block design with a control and

3 dalapon treatments replicated 5 times. At this time the following weekly measurements were taken: leaf number, stem number, height to the highest node. These data were taken at weekly intervals until the end of the experiment. At the end of the experiment, shoot, root and rhizome weight were recorded. Plants were sprayed with 5 mg dalapon on the following dates: June 30, August 18, September 22.

Results

Only a few of the results are presented in this report. A typical response to the N selection throughout the growth period is shown in Figure 1. The lowest concentration of dalapon inhibited the formation of leaves for as long as 3 months after application. After this time, however, growth was resumed at a rapid rate. Application of 5 mg for three times was required for the suppression of leaf growth throughout the entire experimental periods.

Rhizome growth in the 3 concentrations of dalapon and with the 3 johnsongrass selections are presented in Figure 2 . These results are fresh weights of rhizome tissue at the termination of the experiment. These results first of all show that the different number of applications of dalapon (within each selection) has little effect on rhizome growth. In treatments where dalapon was applied 3 times during the experimental period rhizome growth still continued at a rate very similar to treatments where dalapon was applied only once. Figure 2 also shows that the N selection is more susceptible than the other 2 selections.

Summary

The influence of dalapon on 3 selections of johnsongrass has been studied. Results indicated that the N selection is most susceptible, the S selection is most resistant and the NS selection is intermediate in sensitivity to dalapon. The rhizome growth appears to be quite insensitive to dalapon application. The production of fewer rhizomes in the N selection may be the reason for its increased dalapon susceptibility.

Leaf Number

Figure 1. The influence of dalapon treatments on the leaf production of the N selection.

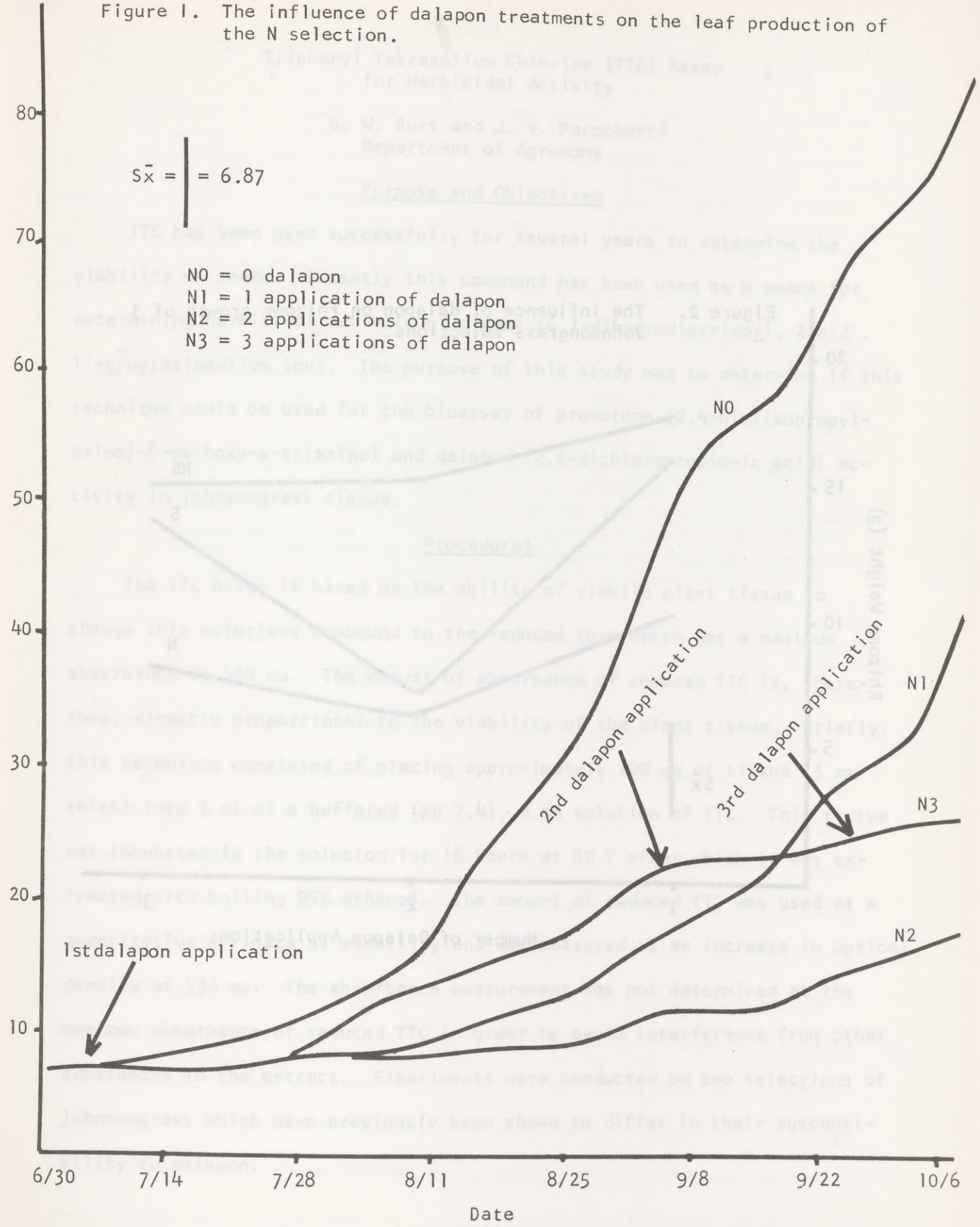
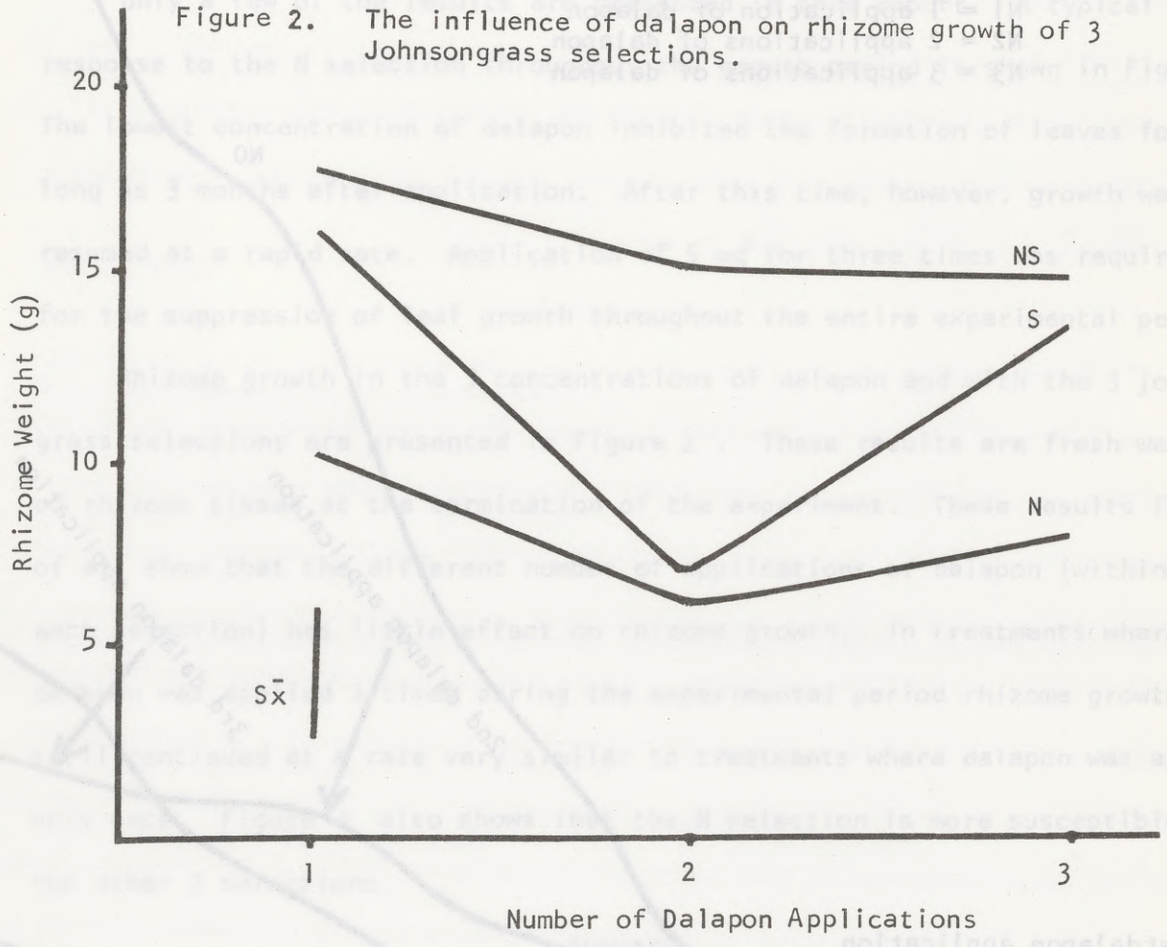


Figure 2. The influence of dalapon on rhizome growth of 3 Johnsongrass selections.



Triphenyl Tetrazolium Chloride (TTC) Assay for Herbicidal Activity

G. W. Burt and J. V. Parochetti
Department of Agronomy

Purpose and Objectives

TTC has been used successfully for several years to determine the viability of seeds. Recently this compound has been used as a means for determining herbicidal activity of diquat (6,7-dihydrodipyrido/1, 2-a:2', 1'-c/pyrazinediium ion). The purpose of this study was to determine if this technique could be used for the bioassay of prometone (2,4-bis(isopropylamino)-6-methoxy-s-triazine) and dalapon (2,2-dichloropropionic acid) activity in johnsongrass tissue.

Procedures

The TTC assay is based on the ability of viabile plant tissue to change this colorless compound to the reduced form which has a maximum absorbance at 490 mu. The amount of absorbance of reduced TTC is, therefore, directly proportional to the viability of the plant tissue. Briefly, this technique consisted of placing approximately 100 mg of tissue (3 mm thick) into 3 ml of a buffered (pH 7.4), 0.6% solution of TTC. This tissue was incubated in the solution for 16 hours at 30 C after which it was extracted with boiling 95% ethanol. The amount of reduced TTC was used as a quantitative estimate of viability and was measured as an increase in optical density at 530 mu. The absorbance measurement was not determined at the maximum absorbance of reduced TTC in order to avoid interference from other substances in the extract. Experiments were conducted on two selections of johnsongrass which have previously been shown to differ in their susceptibility to dalapon.

Results

The TTC reduction along two rhizomes under no herbicidal treatment is presented in Figure 1. These two rhizomes are representative of over 10 rhizomes run in an identical manner. TTC reduction was found to be extremely variable in the first 3 nodes but, thereafter the standard deviation never exceeded an optical density (OD) reading of 0.10. The nodes reduced a consistently greater amount of TTC than the internodes, and no differences were noted between the different johnsongrass selections. Hereafter all data, unless otherwise stated, refers to rhizome internodes farther than 3 nodes from the tip.

There was a great difference between the ability of dalapon and prometone to inhibit the reduction of TTC (Table 1.) In experiments where both dalapon and prometone were placed into the TTC solution, dalapon did not influence TTC reduction at a concentration of 10^{-3} M. Prometone, however, reduced the formation of TTC at a concentration as low as 10^{-5} M. The reduction of TTC with prometone is presented in Table 1.

Since dalapon had no effect on TTC reduction in a time interval of 16 hours, experiments were conducted which subjected tissue to dalapon for as long as 14 days. This was accomplished by soaking the rhizome tissue in dalapon solutions (0, 10^{-5}, 10^{-4}, 10^{-3} M) for 24 hours, placing these in moist vermiculite and subsequently harvesting and assaying for TTC reducing activity. Results of these experiments are presented in Table 2 for both a dalapon susceptible and resistant selection. TTC activity of the dalapon susceptible selection was initially reduced by dalapon treatment, but was increased one week after the initiation of the experiment. The resistant selection responded less and more slowly than the susceptible selection.

Experiments were also conducted to determine the influence of dalapon on the frost hardiness of the rhizomes. In these experiments the rhizomes

soaked in dalapon were incubated for one week in vermiculite, frozen for 24 hours, and subsequently assayed with TTC. Results are presented in Table 3. The dalapon susceptible selection was shown to be less damaged by cold than the dalapon resistant selection. Dalapon increased the frost hardiness at high concentrations in both selections, but reduced frost hardiness at 10^{-5} M in the susceptible selection.

Summary

The reduction of TTC by johnsongrass rhizomes was found to be rapidly decreased in the presence of prometone. TTC, therefore, can be used as a rapid assay for prometone activity in johnsongrass rhizomes. Dalapon, in contrast to prometone, does not immediately influence TTC reduction at concentrations as high as 10^{-3} M. After approximately 1 week, dalapon usually increases the TTC reducing capacity of rhizome tissue. This response depends on the concentration of dalapon and on the selection of johnsongrass used. At high concentrations dalapon increases the frost hardiness of johnsongrass rhizomes.

Figure 1. TTC Reduction Along the Length of 2 Rhizomes

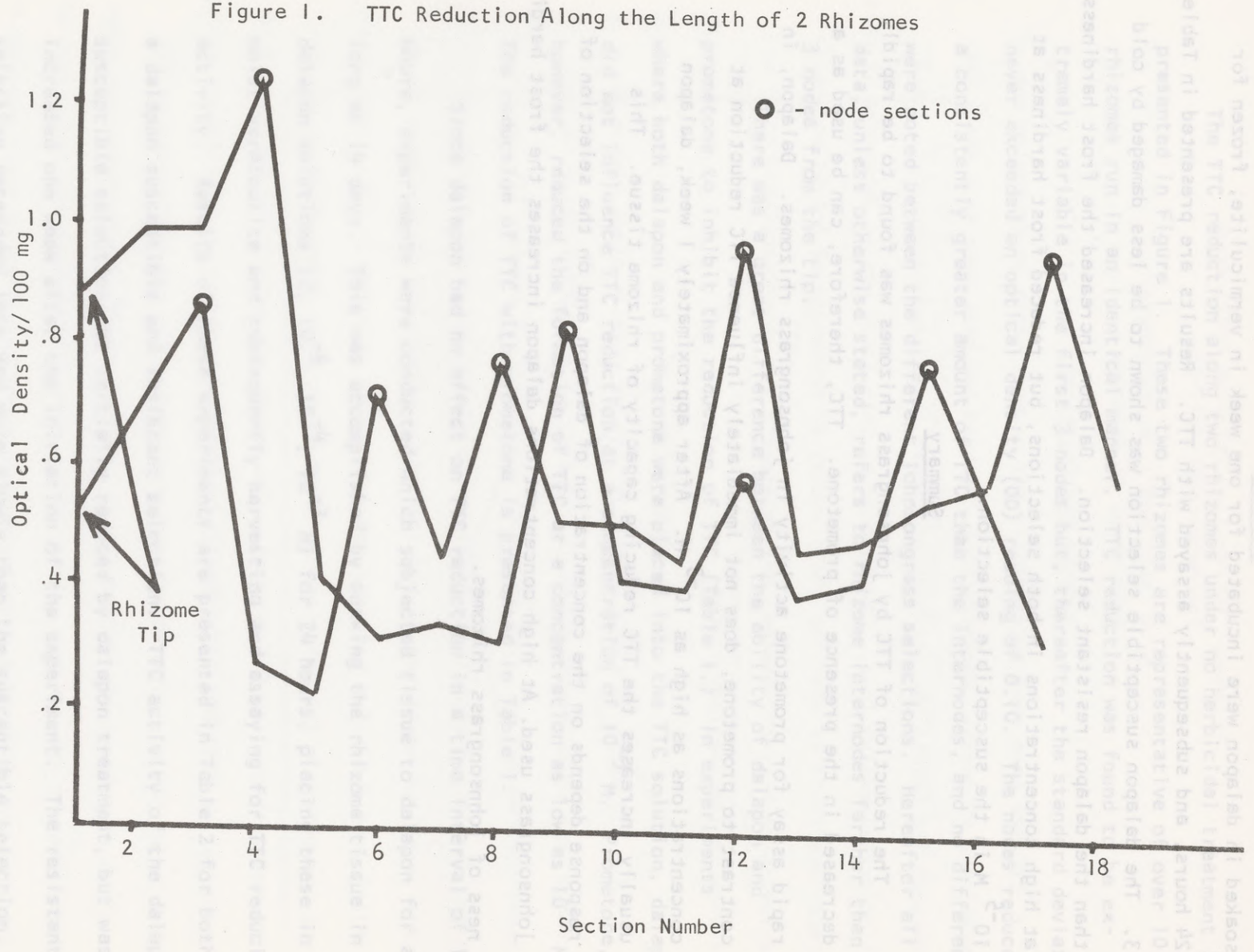


Table 1. The influence of prometone on the reduction of TTC.

Concentration of prometone (M)	Dalapon susceptible selection (OD)	Dalapon resistant selection (OD)
0	.418	.392
10^{-5}	.343	.335
10^{-4}	.216	.289
10^{-3}	.147	.272

Table 2. The influence of dalapon on the reduction of TTC.

	Dalapon Susceptible Selection		Dalapon Resistant Selection	
Concentration of Dalapon (M)	8 days (OD)	14 days (OD)	8 days (OD)	14 days (OD)
0	.57	.51	.35	.33
10^{-5}	.38	.63	.35	.39
10^{-4}	.27	.76	.32	.51
10^{-3}	.29	.41	.37	.45

Table 3. TTC reduction in rhizomes held at -3 and -8 C for 24 hours.

Concentration of Dalapon (M)	Dalapon Susceptible Selection (OD)	Dalapon Resistant Selection (OD)
	-3 C	
0	.344	.271
10^{-5}	.286	.380
10^{-4}	.348	.438
10^{-3}	.411	.528
	-8 C	
0	.016	.005
10^{-5}	.010	.019
10^{-4}	.045	.022
10^{-3}	.033	.020

Gas Chromatographic Analysis of Carbohydrates by Trimethylsilylation

G. W. Burt and J. V. Parochetti
Department of Agronomy

Purpose and Objectives

Johnsongrass selections with different growth habits and herbicidal susceptibilities have been found. The present study was initiated to determine the biochemical reasons for these different physiological states of johnsongrass. Determination of carbohydrates (CHO) was undertaken in this study because of the possible crucial importance of these constituents in herbicidal toxicity and rhizome growth.

Procedures

CHO were extracted by grinding approximately 10 g of rhizomes in a Waring blender for 1 minute with subsequent extracts in a soxlet apparatus with 95% ethanol for 1½ hours to obtain the alcohol soluble monomers. The residue was then extracted for 1 hour in water at 1C to obtain the cold water soluble CHO. The resulting residue was extracted 2 hours in hot water to obtain starch. The three CHO fractions obtained (monomers, cold H_2O soluble, starch) were taken to dryness, reacted with Tri-Sil to produce the Trimethylsilyl (TMS) derivatives which were analyzed by gas chromatography.

The TMS derivatives were analyzed by an Aerography 200, equipped with a hydrogen flame detector and a stainless steel (5' x 1/8") column packed with 5% SE-30 on acid washed 80-100 mesh chromosorb W. The operating conditions were: initial oven temperature, 120C; final oven temperature, 240C; temperature program 6°/min.; injector temperature, 270C; detector temperature, 250C; N_2 carrier gas flow 25 ml/min.; and air flow 250 ml/min.

Results

Several standard sugar TMS derivatives were gas chromatographed to

determine their retention times. These are presented in Table 1 and show the rather long retention times for dimers such as sucrose. It was because of these long retention times for the larger TMS derivatives that a temperature program holding at 240C was required. At the normal oven temperature of 175C retention times were greater than one hour.

Results of the rhizome samples are presented in Table 2. The alcohol soluble fraction gave 4 different peaks. These peaks were tentatively identified as α-D glucose, galactose, β-D glucose and sucrose. The cold and hot H_2O extracts produced no peaks unless hydrolyzed at which time 2 peaks identified as α and β-D glucose were obtained.

Summary

Trimethylsilylation of different carbohydrate extracts from johnsongrass rhizomes has been successfully used to separate and analyze the carbohydrates present. Glucose, galactose and sucrose appear to be the most abundant sugars present. Subsequent quantitative analysis to compare carbohydrate components in different johnsongrass selections under dalapon treatment will be conducted.

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Table 1. Retention times (Min.) for TMS standards.

L-arabinose	7.8
D-ribose	8.4
D-xylose	9.6
β-D-fructose	10.8
D-mannose	12.0
L-sorbose	12.3
α-D-glucose	12.6
D-galactose	12.8
β-D-glucose	15.6
Sucrose	25.8
Lactose	28.6
Maltose	31.2

Table 2. Retention times (Min.) for rhizome carbohydrate extracts.

Extract	α-D-glucose	D-galactose	B-D-glucose	sucrose
Alcohol	12	13	15.0	25
Cold water (hydrolyzed)	12.2		13.9	
Hot water (hydrolyzed)	12.4		14.7	

The Effects of Variety, Selection, and Production Methods of Corn on the Feeding Value of Corn Silage

N. A. Clark
Department of Agronomy

Purpose and Objectives

The overall project objectives of this study are to determine the effects of genetically controlled morphology, planting rate, soil nutrient relationships, and time of harvest on the following components of silage corn:

1. yield
2. ear-stalk ratio
3. fiber and lignin content
4. protein content
5. nitrate content
6. TDN
7. ripening characteristics
8. mineral content

This research was conducted in cooperation with the Department of Dairy Science as most of our silage work is cooperative between the two departments. There is presently interest among dairy nutritionists in feeds low in potassium. Our immediate objective was to produce corn silage with low to high ranges of K, and also to study the effect of K balance on nitrate nitrogen, lignin, and other minerals in the plant tissue.

Procedures

The experiment was set up as an incomplete factorial consisting of the following fertilizer treatments:

1. Check
2. N
3. K
4. Mg
5. Ca
6. N + K
7. N + Mg
8. K + Mg
9. K + Ca
10. N + K + Mg

The experimental design was a randomized complete block with 4 replications. Each plot consisted of four 30-inch rows, 30 feet in length. The plant population was 30,000/A. The following sources were used to supply the

elements listed above:

N - ammonium nitrate
K - potassium chloride
Mg - magnesium sulfate
Ca - ground agricultural limestone

N was applied at 300 pounds per acre, K at 500 pounds per acre, Mg at 300 pounds per acre, and CaO at 2000 pounds per acre all of which passed a 20 mesh screen and 60 percent which passed a 100 mesh screen. Phosphorous was applied uniformly over the entire experimental area at a rate of 130 pounds per acre. All the materials were applied with a Gandy spreader and disked in immediately before planting. The corn was planted on May 16 using the variety DeKalb XL66. Immediately after planting, the entire area was sprayed with 4 pounds of atrazine per acre.

Plant samples were taken at random from each plot at the full silk stage and silage stage at 45% DM. The plants were divided into stalks and leaves, and for the last sampling the cobs and kernels were also collected separately.

All yield data have been statistically analyzed and are reported in Table 1. A modified micro-Kjeldahl N analysis was developed in which the predigested plant sample solution is passed directly into an AutoAnalyzer. This step avoids the regular tedious titration step and the N percentages read directly from the AutoAnalyzer by means of a recording chart. Mineral and cell wall determinations are now being conducted.

Results

Yield and lodging results are reported in Table 1. Total silage yield was highest in the N + K and N + K + Mg treatments. All single cation treatments except Mg were lower in yield than those in combination with another cation. Grain yields from the N and K treatments were the lowest recorded in the experiment, but in the combination N + K the yields were highest. Lodging was greatly accentuated by the N + Mg treatment. The

addition of K to other cations signficantly reduced lodging.

Summary

Corn was grown under high and low levels of N, K, Mg and Ca. The N + K + Mg yielded the best of all combinations. The N + K treatment was not significantly different from the N + K + Mg treatment in total, stover, and grain yield and in lodging percent. Magnesium alone decreased overall silage yield and in combination with N had the highest lodging percent.

Table 1.

Corn Silage Harvest Yields and Lodging Percent
(September 29, 1969)[1]

Treatment	30% DM silage			
	Whole Plant	Stover	Grain Yield	Lodging
	T/A	T/A	bu/A	%
Check	19.5 bc*	9.6 b	117 a	19 b
N	19.6 bc	8.9 a	103 a	23 b
K	22.0 cd	8.3 a	105 a	15 b
Mg	15.7 a	8.5 a	119 a	14 b
Ca	20.4 bc	10.0 bc	131 b	17 b
N + K	25.2 d	11.1 c	148 c	9 a
N + Mg	22.9 cd	9.2 ab	141 b	34 c
K + Mg	21.4 bc	9.7 b	115 a	11 a
K + Ca	21.3 bc	9.0 ab	120 a	6 a
N + K + Mg	25.0 d	11.3 c	155 c	5 a

[1] Variety DeKalb XL66, population 30,000.

*Means with the same letter within a column are not significantly different.

The Response of Corn and Alfalfa to Fertility and Irrigation

N. A. Clark
Department of Agronomy

Purpose and Objectives

This study compares corn and alfalfa under three fertility levels, and with overhead irrigation, subirrigation, and no irrigation. Subirrigation using plastic pipe is a recent development, and it has been postulated that it might differ in water use from overhead systems due to differences in evaporation and water movement into the subsoil. Objectives of the study were to compare irrigation systems and the efficiency of fertilizer use under the three irrigation regimes.

Procedures

The experiment was a split plot design with irrigation regimes as whole plots. Crops and fertility treatments were assigned at random as subplots within each whole plot. There were three replications. The crops were: alfalfa, corn silage, corn grain, double crop corn silage - small grain silage. Fertilizer treatments were: 1/2 soil test recommendation, soil test, and double soil test. Overhead irrigation was by a Skinner sprinkler system and subirrigation was by means of 1/2 inch plastic pipe with 0.3-inch holes at one-foot intervals along the pipe. The pipe was buried one foot deep, and the pipes were spaced every three feet the length of the whole plot. Pressure was maintained at three pounds by a tank with a leveling float at the head of each subirrigation plot.

Planting and harvest dates are shown in Table 1, and fertilizer treatments are in Table 3.

Results

Rainfall and irrigation is shown in Table 2, and yields in Table 4.

Rainfall was limited in the spring, but from June on the picture improved considerably with over three inches in June and over four inches per month thereafter. Irrigation water was applied whenever soil moisture stress induced wilting in the plants. Subsurface irrigation could be applied at any time, but overhead irrigation required wind-free conditions. Often no water could be applied for several days at a time with the overhead systems because of wind.

Alfalfa yields (Table 4) show no significant differences due either to fertilizer treatments or irrigation regime. Weed encroachment and leaf diseases were prevalent in all plots and stands were depleted by the end of the season. Only four tons of forage were obtained from five harvests. The nonirrigated plots had better stands but were limited by moisture while the irrigated plots had more productive plants, but reduced stands due to more diseases and weeds.

Corn grain yields (Table 4) were lowest in the nonirrigated plots and highest in the overhead irrigated plots. Under nonirrigated conditions the medium and high fertilizer treatments gave greater yields than the low treatment. However, under irrigation this was a non-significant trend. Lodging was pronounced in the high fertility plots under irrigation. It was especially severe in plots at the north end of the experimental area which was more exposed to high winds associated with a heavy rain in late July. The lodging caused a substantial reduction in yield in the high fertility irrigated plots.

Single crop silage yields (Table 4) showed an increase with increasing fertilizer levels under all irrigation regimes with the exception of low and medium fertility with no irrigation, and in this case the yields were

equal. The highest yields were for overhead irrigation with subirrigation next and no irrigation the lowest.

The wheat crop which was removed as silage in the double crop sequence responded with increased yields to the increasing levels of fertilizer applied (Table 4). There was however, no response to irrigation regime and this would be expected as no irrigation water was applied while the wheat crop was being grown. The corn silage crop which was planted following removal of the wheat yielded approximately one half that of the crop obtained from the single crop silage corn (Table 4). In this case, however, the same response patterns to fertilizer and irrigation as with the single crop was obtained. The dry matter per acre obtained from the single crop silage was greater than the combined yield, of wheat and corn from the double crop sequence. It should be pointed out, however, that the wheat yields were somewhat lower than would normally be expected due to problems with the grain drill used in 1969 which resulted in an unsatisfactory stand.

Summary

Corn silage, corn grain, wheat silage-corn silage double crop, and alfalfa were compared under three fertility levels; and with overhead irrigation, sub-surface irrigation, and no irrigation. Approximately 1.5 inches of water was applied in the overhead system and less than two inches in the subirrigation system. This was applied in May and July in the case of the overhead and May, June, and July for the subsurface system. Rainfall from July on was adequate for good plant growth with over four inches occuring each month. Alfalfa yields were not affected by either fertilizer or irrigation treatments, but by the end of the growing season the stands of alfalfa under irrigation were badly depleted due to disease and weeds. Corn grain yields were increased by both irrigation and high fertility, but

lodging occurred under these conditions. Corn silage yields were also increased by high fertility and irrigation in both the single crop and double crop treatments. The single crop silage yields, however, were approximately twice that of the double crop corn silage. Wheat silage yields showed increases with increasing fertilizer, but as no irrigation water was applied to this crop and no irrigation effect was obtained.

Table 1.

Planting and Harvest Schedules

Crops	Planting date	Harvest date
Wheat	10/14/68	5/26/69
Alfalfa (WL303)	4/15/68	5/13-6/12-7/18-9/18-10/1/69
Corn grain (DeKalb XL66)	5/ 1/69	10/28/69
Corn silage (DeKalb XL66) (fallow)	5/ 1/69	9/ 2/69
Corn silage (DeKalb XL45) (double crop)	6/ 2/69	9/20/69

Table 2.

Rainfall and Irrigation

Month	Rainfall* (inches)	Irrigation applied (inches)	
		Overhead	Subirrigation
April	2.29	--	--
May	1.83	0.61	0.43
June	3.11	--	1.00
July	5.27	0.86	0.43
August	4.42	--	--
September	4.34	--	--

* Recorded at Clarksville 3N

Table 3.
Fertilizer Application

Crop	Fertility Level	Fertilizer Applied N	P_2O_5	K_2O	How Applied
Wheat	Low	6	12	12	Disked in before
	Medium	12	24	24	planting
	High	24	48	48	
Alfalfa	Low	0	45	90	Broadcast
	Medium	0	90	180	
	High	0	180	360	
Corn Grain	Low	45	20	20	Plow down
		10	10	10	planter
	Medium	90	40	40	Plow down
		20	20	20	planter
	High	180	80	80	Plow down
		40	40	40	planter
Corn Silage (fallow and double crop)	Low	66	30	30	Plow down
		3.7	7.5	11.2	planter
	Medium	132	60	60	Plow down
		7.5	15	22.4	planter
	High	264	120	120	Plow down
		15	30	45	planter

Table 4.

Yields of Alfalfa, Corn Grain, Corn Silage (fallow), Wheat Silage, and Corn Silage (double crop)

Irrigation Regime	Fertility Level	Alfalfa DM	Corn Grain	Corn Silage (fallow) DM	Wheat Silage DM	Corn Silage (Double crop) DM
		T/A	Bu/A	T/A	T/A	T/A
No Irrigation	Low	4.3	72.7	6.6	1.6	3.4
	Medium	4.1	90.8	6.6	2.1	3.6
	High	4.4	95.4	7.5	2.4	3.5
Sub-Irrigation	Low	4.3	110.3	7.9	1.7	3.4
	Medium	4.1	120.6	8.5	1.5	4.9
	High	4.4	99.9	9.2	2.6	4.3
Overhead Irrigation	Low	4.6	124.7	8.5	1.8	4.4
	Medium	4.1	130.3	9.4	2.1	4.4
	High	4.1	129.7	9.9	2.4	5.1

Plant Environmental Studies

A. M. Decker and D. T. Hawes
Department of Agronomy

Purpose and Objectives

The purpose of the experiment was to study the responses of forage and turf species to controlled soil temperature in the field under otherwise "natural" environment. Much research has been conducted in the field under "natural" conditions where environmental variables may be measured but not controlled. At the other end of the scale, growth chamber experiments provide us with plant responses to rigidly controlled and monitored environments. Both types of studies have contributed to a better understanding of plant growth but much remains unanswered.

The first objective of this study was to take a closer look at the reactions of forage grasses and legumes to modified soil temperatures in the field. The second was to study responses of turf species to the same temperature regimes. These objectives were aimed toward gaining basic information on plant-environment interactions and a practical means of maintaining good turf on athletic fields during periods of adverse soil temperatures.

Procedures

Forage Species Clonal material from Climax timothy used in 1968 was started in pots in the greenhouse and moved to the field in mid-May. Pots were buried so that the tops were level with the soil surface. Top growth was removed twice in the greenhouse and again on June 15 when the experiment was started. Leaf developmental readings on selected tillers were made twice each week starting June 19. Forage yields were obtained on July, August, and September 15, 1969 at a stubble height of two inches. The plants

were randomly divided into three groups. One group was removed at each harvest. Crown weight (including stubble), root weight and new plus total live tillers were determined on half of the plants. The other half was placed in a dark growth chamber where growth was used as a measure of plant reserves.

Seedling plants of Dollard and MD-Syn I red clover were started in the greenhouse and placed in the field using the same procedure described for timothy. Characterization of the clover plants was similar to that used for timothy except that sufficient plants were not available for growth in the dark chamber and more observations on the root and crown were made.

Turf Species Sod of Penncross bentgrass, Merion bluegrass, Tufcote bermudagrass, and Ky-31 tall fescue was laid on temperature plots May 1, 1969. These were subsequently topdressed three times to fill cracks and smooth the surface. A split-plot experiment with Penncross consisted of the following: Main plots; ambient, 10C, 21C, and 32C; Split plots; preventative vs. curative pythium control using Koban, Split-split plots; (1) 2 lbs. N early June plus four 1-lb rates late June to September, (2) 1 lb. N early June plus four ½-lb. rates late June to September, (3) same as #2 plus K at one half rates of N, (4) same as #3 plus minor elements, (5) 1 lb. N early June plus four 1/8-lb. rates June to September. Urea-formaldehyde and potassium sulfate were the N and K sources. Turf color readings were made weekly with a Ratiospect. Two-inch plugs were taken monthly from each treatment. Some were placed in dark growth chamber for plant reserve measurements and others were used to obtain root and tiller development data. Similar measurements were made less frequently on non-replicated plots of bluegrass, tall fescue, and bermudagrass grown at one fertility level.

Results

Forage Species The responses of timothy are given in Table 1. Forage yields were highest at 10C and lowest at 32C. At 10 and 21C yields increased as the season progressed while a decrease occured at ambient and 32C. The same general pattern occured with crown, root, and tiller development as well as plant reserves as measured by growth in the dark. The general performance was best at 10C followed by 21C, ambient and then 32C.

Optimum yields for red clover were at 21 rather than 10C for timothy (Table 2). Greatest variation in yield was with Dollard. At 10 and 21C the yields of Dollard and MD-Syn I were almost identical but at 32C and ambient MD-Syn I was superior. The effect of soil temperature on crown and root development was more dramatic than on top growth. At 10C Dollard grew relatively better than MD-Syn I while at all other temperatures MD-Syn I was superior. High soil temperatures resulted fewer healthy appearing roots.

Turf Species Clipping yields of cool-season grasses was highest for 21C and ambient and lowest at 10 and 32C. The latter started with a flush of growth but for most of the season was at a low level with 10C. Bermuda yields increased with increased temperature.

No Pythium was observed on any of the treatments. Brown patch, the only disease observed, was present only on the 32C plots and did not appear to be associated with Koban applications.

Reflectance readings were closely associated with clipping yields. Color readings for cool-season species at 10 and 32C were equally poor but for very different reasons. Turf on 32C plots thinned and was slow to heal while 10C plots were off color because of nitrogen deficiency. These effects became more pronounced as the season progressed. Only at 10C was there

a distinct color difference between low and high nitrogen. Color on bermuda increased as temperature increased.

Plant reserves were highest at 10C and lowest at 32C with greatest differences for cool-season species.

As the season progressed bentgrass roots were highest at 10C and lowest at 32C. Tillers were low at 10 and 32C and high at 21C and ambient.

Summary

1. Soil temperatures differentially affected top growth, root growth, and tiller development of timothy, two red clover selections, and four turf species.
2. General performance for timothy was best at 10C but for red clover it was 21C.
3. Dollard red clover performed relatively better than MD-Syn I at 10C but at all other temperatures the reverse was true.
4. High soil temperature produced increased root discoloration of red clover - especially Dollard.
5. Plant reserves for cool-season species was highest at 10C. Greatest root and tiller development also occured at this temperature.
6. Turf quality for cool-season species was highest at 21C and ambient while bermuda was best at 32C.

Table 1. Response of Climax timothy to four soil temperature regimes. 1969.

Soil temperature	Date	Plant Characterization at Harvest: Grams per plant: Forage Yield	Crown[1]	Root	Total	Live tillers/plant: New	Total	Tiller growth in Dark: Tiller No./plant	Weight g/plant
Ambient	7-15	6.27	5.28	3.41	8.69	10	84	47	0.68
	8-15	7.28	10.48	5.21	15.69	12	108	60	1.83
	9-15	5.22	8.06	3.48	11.54	8	102	70	1.69
	Av.	6.26	7.94	4.03	11.97	10	98	59	1.40
10C	7-15	6.28	6.50	4.23	10.73	12	94	30	1.09
	8-15	6.85	3.12	7.57	10.69	16	140	104	2.76
	9-15	10.47	17.92	11.76	29.68	25	235	102	4.20
	Av.	7.87	9.18	7.85	17.03	18	156	79	2.68
21C	7-15	4.90	5.19	3.00	8.19	2	78	53	1.06
	8-15	7.21	8.54	5.91	14.45	6	117	33	0.89
	9-15	6.98	14.84	7145	22.89	11	174	68	1.67
	Av.	6.36	9.52	5.45	15.18	6	123	51	1.21
32C	7-15	4.49	4.51	2.32	6.82	14	70	52	1.08
	8-15	3.76	6.24	3.29	9.53	12	76	31	0.92
	9-15	3.29	6.55	3.04	9.59	3	57	33	0.89
	Av.	3.85	5.77	2.88	8.65	10	68	39	0.96

[1] Crown includes two-inch stubble left at harvest.

Table 2. Response of two red clover selections to four soil temperature regimes. 1969.

Soil temperature	Variety	Date	Plant Weight at Harvest in grams per plant: Forage Yield	Crown[1]	Root	Total	Live tillers/ plant	Width of tap root at Crown (cm)
Ambient	Dollard	7-15	16.60	1.94	1.56	3.50	14	11
		8-15	16.14	2.85	2.48	5.33	27	11
		9-15	7.85	2.67	3.42	6.09	43	12
		Av.	13.53	2.49	2.49	4.97	28	11
	MD-Syn I	7-15	12.43	1.57	1.32	2.89	9	10
		8-15	14.23	3.06	2.52	5.58	23	12
		9-15	14.76	3.81	5.59	9.40	58	17
		Av.	13.81	2.81	3.14	5.96	30	13
Av.			13.67	2.65	2.82	5.46	29	12
10 C	Dollard	7-15	12.74	2.02	2.54	4.56	13	14
		8-15	12.92	4.14	5.18	9.32	29	17
		9-15	10.75	3.65	5.66	9.31	62	20
		Av.	12.14	3.27	4.46	7.73	35	17
	MD-Syn I	7-15	13.54	3.48	3.88	7.36	24	16
		8-15	11.65	2.92	2.98	5 90	26	17
		9-15	10.91	4.60	4.98	9.58	63	17
		Av.	12.03	3.67	3.95	7.61	38	17
Av.			12.08	3.47	4.20	7.67	36	17
21 C	Dollard	7-15	13.75	1.87	1.86	3.73	42	10
		8-15	15.30	3.41	3.53	6.94	33	14
		9-15	13.27	4.08	4.35	8.43	47	7
		Av.	14.11	3.12	3.25	6.37	41	10
	MD-Syn I	7-15	15.08	1.74	1.98	3.72	16	10
		8-15	15.91	3.02	2.75	5.77	29	14
		9-15	15.60	5.97	5.99	11.96	75	19
		Av.	15.53	3.58	3.57	7.15	40	14
Av.			14.82	3.35	3.41	6.76	40	12
32 C	Dollard	7-15	12.11	2.64	2.30	4.94	17	12
		8-15	6.80	1.28	1.89	3.17	14	11
		9-15	6.35	1.95	2.37	4.32	31	11
		Av.	8.42	1.96	2.19	4.14	21	11
	MD-Syn I	7-15	11.75	1.83	1.87	3.70	16	10
		8-15	10.63	1.94	2.06	4.00	18	11
		9-15	9.40	2.58	3.72	6.30	31	12
		Av.	10.59	2.12	2.55	4.67	22	11
Av.			9.50	2.04	2.37	4.40	22	11

[1] Includes two-inch stubble left at harvest.

Pasture Evaluation Using Beef Steers

A. M. Decker
Department of Agronomy

Purpose and Objectives

In 1950, there were 77,000 beef cattle in Maryland. Six years later this number had more than doubled. From 1956 to the present time numbers have leveled off with 148,000 reported for 1968. While cattle numbers have increased there are many fewer acres of pasture now than in 1950. If pastures are to continue to play an important role in the beef industry greater production per acre must be realized from these pastures. Small-plot studies and recent grazing studies have demonstrated the superiority of Midland bermudagrass pastures sod-seeded with a mixture of rye and wheat. In the past, animal performance on Midland has always been measured where the pastures were rotationally grazed. The objective of this study was to evaluate these pastures grazed either rotationally or continuously.

Procedures

A three-year study testing the productivity of Midland bermudagrass pastures sod-seeded with a mixture of rye and wheat fertilized at 200 and 400 pounds of nitrogen per acre was concluded in the fall of 1968. The procedure was changed in 1969. A rest period of 15 to 25 days was used on the rotational pastures. Whenever grazers were added to or removed from rotational pastures the same animal changes were made on the corresponding pasture being continuously grazed. The stocking rate, then, was set by the amount of forage present on the rotational pastures of a particular nitrogen treatment. Except for a few times when forage was uniformly and completely utilized, rotation pastures were clipped after each grazing. The continuously grazed pastures

were clipped once in early summer to remove the mature, ungrazed seed heads of rye and wheat.

All animals used in the experiment were Hereford steers purchased at the fall feeder calf sale and uniformly fed during the winter. Just prior to being placed on experimental pastures, they were divided into uniform tester groups according to weight and rate of winter gain. The groups were then assigned at random to individual treatments where they remained throughout the grazing season. The most uniform animals with regard to rate of gain and weight were used as testers. Those animals on either extreme were used as grazers.

The experimental design was a randomized block with two replications.

Results

A brief summary of results obtained are given in Table 1. Rainfall was near normal during most of the grazing season with the result that good forage production was obtained. Since this experiment was being terminated the bermuda pastures were not sod-seeded in the fall of 1969. In spite of this fact, experimental pastures were grazed until late October (30 days after any significant growth of the Midland). However, because young growth of wheat and rye was not present most animals lost weight during the last few weeks. This loss was greater on the low nitrogen pastures. Because of past history, all pastures had a high residual nitrogen with the result that differences between nitrogen levels were small. Carrying capacity and daily animal gains were increased slightly with higher nitrogen but only 29 pounds more beef per acre were realized. Daily gains, carrying capacity and beef production per acre were similar for rotational and continuous grazing with the latter being slightly better. Dry matter production for both nitrogen levels was similar on the rotation pastures. Dry matter was not determined

on the continuously grazed paddocks but large differences were not apparent to the observer. The most noticeable difference was that the high nitrogen paddocks were grazed more uniformly and fewer weeds were present. Based on one year's results, it appears that the only benefit of rotational grazing of Midland bermudagrass pastures is that excess forage produced during periods of good growth can be more efficiently harvested for hay or silage. As far as the type of grazing is concerned there appears to be little advantage to either the crop or the animal.

Summary

1. There was no advantage of rotation over continuous grazing of Midland bermudagrass pastures sod-seeded to a mixture of rye, wheat, and hairy vetch.
2. More uniform utilization of forage at high nitrogen was observed.
3. From the production standpoint there was no advantage for more than 200 lbs N/A.
4. Even though Midland stops growing around mid-September, it can be grazed, until late fall. This would be especially true for brood cows. In this case they could be left on such pastures all winter and fed stored feed primarily during January and February. Such a program could greatly reduce the wintering costs.

Table 1. Performance of Midland bermudagrass pastures sod-seeded to a mixture of rye-wheat and hairy vetch. 1969

Treatment		Forage available	Carrying capacity (1000 lb AV)	animal gains	Pounds of beef
Nitrogen Lbs/A	Grazing System	T/A	No.	Lbs/day	Lbs/A
200	Continuous[1/]	----	2.97	1.48	631
200	Rotation	10.07	2.87	1.50	595
400	Continuous[1/]	----	3.16	1.54	647
400	Rotation	10.40	3.06	1.52	636
	Average:	10.23	3.01	1.51	627

[1/] Yields of dry matter not obtained. The number of animals was the same for continuous and rotation pastures within each nitrogen level.

Evaluation of Sod-Seeding to Improve Production of Permanent Grass Stands

A. M. Decker
Department of Agronomy

Purpose and Objectives

The production from many of our permanent forage species can be improved by sod-seeding one or more species into the existing sod. For example, summer production of bluegrass pastures has been significantly increased with sod-seeded trefoil or crownvetch. The growing season of Midland bermudagrass has been extended and production per acre increased by the use of sod-seeded cool-season species, both annual and perennial. The rate of nitrogen fertilization becomes very important in final yields obtained from Midland fields which are sod-seeded with a cool-season grass. The objectve, then, during the past year was to evaluate various fertilizer-sod seeding combinations with regard to returns per acre. Efforts during the year have also been directed toward publication of experimental results.

Procedures

Yield data collected during the past several years from Midland bermudagrass were subjected to a simple economic analysis. Procedure and cost values for this analysis were taken from "Maryland Farm Planning Data and Supplement, Agricultural Economics 1966. G.A. Stevens and J.W. Wysong." Forage value was obtained by using average alfalfa-red clover hay price received by the Maryland farmer over a five-year period less 15%. All forages were adjusted to 14% crude protein ($0.06 per pound). Net dollars return per acre were calculated for 17 combinations (net return = return above seeding and fertilizer cost and does not include harvesting, land costs, etc. which would be similar for all combinations.)

Results

Total variable cost and net return per acre for three years (good moisture, poor moisture, and average moisture years) are given in Table 1. Net returns ranged from a low of $21.21 to a high of $218.12. During years of average to good precipitation sod-seeded rye significantly increased net return. At least 400 pounds of nitrogen was necessary for maximum return. Once the necessary nitrogen was applied to the Midland there was no advantage to applying extra nitrogen when sod seeding. The greatest advantage for sod-seeded rye was when high nitrogen rates were applied. Hairy vetch added to the cereal rye increased returns especially during years with poor moisture distribution.

Summary

1. Sod seeding of cereal rye was profitable only at high nitrogen fertilization.
2. Although greatest return from sod seeding and nitrogen fertilization occurs during years with good moisture, the relative advantage still exists during dry years.
3. When adequate nitrogen is applied to the Midland sward during the summer, there is no advantage to adding more when cool-season crop is sod-seeded.
4. Hairy vetch will increase yield and net return when added to sod-seeded rye.

Table 1. Estimated Variable Cost and Return Per Acre Above these Costs for Various Combinations of Midland Plus Sod-Seeded Species

Midland	Crop	Total Variable Cost	Net Return Above Variable Cost			
			Precipitation during growing season			
			Good	Average	Poor	Average
lbs/A	lbs/A	$	$	$	$	$
200	0	41.36	81.80	109.95	54.37	82.04
400	0	80.44	167.34	193.69	85.38	148.80
800	0	158.60	156.95	176.43	25.94	119.77
200[1]	0	49.75	100.95	98.31	50.31	83.19
	20	52.46	101.32	98.27	35.40	78.33
	40	55.17	98.75	107.60	33.58	79.98
	80	60.58	116.95	111.13	21.21	83.10
400[1]	0	88.63	198.87	154.40	53.99	135.75
	20	91.54	206.71	167.21	65.37	146.43
	40	94.25	194.94	179.34	59.54	144.61
	80	99.66	212.13	185.31	37.94	145.13
800[1]	0	166.99	218.12	157.44	93.90	156.49
	20	169.70	165.04	155.57	85.12	134.91
	40	172.41	188.27	156.81	97.77	147.62
	80	177.82	158.25	185.55	83.45	142.42
200[2]	20	52.46	95.12[3]	110.96	115.41	107.31
400[2]	20	91.54	205.93	172.03	123.85	167.26

[1] sod-seeded cereal rye

[2] sod-seeded cereal rye plus hairy vetch

[3] poor stand of hairy vetch - good other years

Midland Bermudagrass Forage Production, Feed Value, and Stand Persistence as Affected by Nitrogen Fertilization and Harvest Schedules

A. M. Decker, N.A. Clark, and R. W. Hemken
Departments of Agronomy and Dairy Science

Purpose and Objectives

Since the development of Coastal bermudagrass, acreage of this species has increased markedly. Considerable information has been accumulated regarding fertilization and management of Coastal but relatively little on Midland which is winter hardy enough to be grown in Maryland. Midland has been extremely productive on Maryland's Coastal Plain as well as the lower Piedmont. The purpose of this study has been to further study the forage producing capacity of this grass and obtain information on its feed value as influenced by fertilization and harvest schedules. The first of these objectives has been largely concluded and most of the time during 1969 was spent completing the quality evaluations of Midland hays.

Procedures

During the past several years Midland hays which had been fertilized with different rates of nitrogen and cut at varying stages of maturity were collected. All hays were analyzed for cell wall constituents, acid-detergent fiber, lignin, and protein using standard chemical procedures. Hays were fed to dairy steers for determination of digestion coefficients and forage intake values again using standard procedures for these determinations.

In addition to completing forage quality evaluations considerable time had been devoted to summarization of experimental results and preparing them for publication.

Results

Considerable variation existed from year to year with regard to chemical composition, digestion coefficients, and intake values. However, there were definite patterns regarding these characteristics. In general, as stage of growth increased, crude fiber, acid-detergent fiber, cell wall constituents, and lignin increased while crude protein and gross energy decreased. Digestion coefficients of all of these increased as the forage was harvested at a less mature stage. Although a significant drop in digestion coefficients occured between three and four weeks of growth, the largest drop was after four weeks of growth. Dry matter intake increased as forage was harvested at a less mature growth stage. There was also greater dry matter intake of Midland fertilized at 600 rather than at 200 pounds of nitrogen per acre.

Summary

1. Fibrous fractions increased with advancing maturity.
2. Crude protein decreased with advancing maturity.
3. Digestion coefficients decreased with advancing maturity.
4. Intake values decreased with advancing maturity and increased with nitrogen fertilization.

Development of Techniques for Producing Tobacco Seedlings in Pressed Peat-Soil Cubes

J. H. Hoyert
Department of Agronomy

Purpose and Objectives

The purpose of this work was to develop new methods of growing tobacco plants which would have potential for improved seedling uniformity, further mechanization of transplanting and labor reduction. The lack of uniformity -- because of irregular transplants -- has been one of the major problems in the total mechanization of tobacco harvesting. This new system of producing seedlings in cubes offers a potential for mechanization of transplanting which does not exist under the conventional system of plant production.

The objectives of this study were:

1. To compare growth of transplants in a pressed peat-soil cube and peat pots to a conventional transplant as measured by yield, price per pound and acre value.

2. To investigate the feasibility of discontinuing the use of water with transplants.

Procedures

This experiment was located at the Tobacco Experimental Farm on a Monmouth sandy loam soil. Catterton variety was used at a plant population of 7,260 per acre. Fertilizer was broadcast at a rate of 60-120-180 lbs. per acre. Experimental design was a randomized complete block with four replicates. Plots were one row of 24 plants which was 3 by 48 ft. in size.

Treatments used were commercially available square peat pots of 1-3/4 inch size and pressed peat soil cube approximately 20% soil, 50% sphagnum peat, 20% vermiculite and 10% perlite by volume. The soil used in this mix was

Monmouth sandy loam with a mechanical analysis of: 67% sand, 16% silt and 17% clay. The third treatment was a selection of conventional transplants carefully pulled from the plant bed according to uniformity of size and shape. The control treatment consisted of conventional transplants which were pulled as the average grower draws plants with no extra attention paid to uniformity.

Each of these four treatments were transplanted with 1/2-pint of water placed at the roots during the planting operation. The four treatments were repeated with no water used at transplanting. These eight treatments were planted into field plots on June 19, 1968 and harvested on August 16, 1968.

Early rainfall was excellent and the plants in all treatments initiated growth with no observable stress.

Results

The field results are presented in Table 1 and indicate that there were no significant differences between any of the treatments in yield, price or acre values. It appears that all types of transplants, with or without water, compare favorably with the control treatment. The estimates of relative uniformity with the control treatment arbitrarily set at 100 were not conclusive but there seem to be some trends. When water was used with the transplant, uniformity was improved. The specially selected plant, peat-soil cube and the peat pot treatment appear superior in uniformity to the control.

Summary

1. All of the types of transplants tested, with or without transplant water, performed satisfactorily compared to the conventional control treatment.
2. The specially selected plant, peat-soil cube and peat pot treatments where water was used in transplanting resulted in more uniform tobacco than the control treatment.

Table 1. Yield, price, acre value and uniformity of various types of tobacco transplants. 1968.

Treatment	Yield lbs/A.	Price ¢/cwt.	Value $/A.	Estimate of relative uniformity
(with transplant water)				
Control	1502	66.71	1005	100
Selected plant	1463	63.16	923	220
Peat-soil cube	1430	66.38	949	193
Peat pot	1505	66.51	1000	191
(without transplant water)				
Control	1470	67.04	985	123
Selected plant	1456	67.88	989	134
Peat-soil cube	1469	68.00	998	122
Peat pot	1473	64.91	955	149
	N.S.	N.S.	N.S.	
C.V. =	5.9%	4.7%	7.2%	

The Use of Various Chemical Growth Regulators to Improve Ripening Rate and Maturity of Maryland Tobacco

J. H. Hoyert
Department of Agronomy

Purpose and Objectives

There is a need for work on narrowing the range of maturities between the lower and upper leaves of the tobacco plant at harvest time. Maryland tobacco is stalk-cut at that critical time when the middle leaves are of optimum ripeness, the lower leaves are overmature, and the top leaves are immature. This wide range is a limiting factor to new procedures of harvesting and curing being developed for labor reduction.

The objective of this study is to compare the effect of various chemical growth regulators upon the rate of ripening and the maturity of cured leaves.

Procedures

This investigation was located on a Monmouth fine sandy loam at the Tobacco Experimental Farm. Catterton variety was planted at population of 7,260 plants per acre with 60-120-180 lbs. of fertilizer broadcast per acre. The design was a randomized complete block with three replicates. Plots were one row of 30 plants or a size of 3 by 60 ft.

There were 11 chemical growth regulators in addition to the control treatment used in this experiment. The chemicals were: Giberellic acid, Benzyl Adenine, Dimethyl Amino Succinic Acid, 2,4-D (50 mg./plant), 2,4-D (100 mg./plant), 2,4,5-T (50 mg./plant), 2,4,5-T (100 mg./plant), Ethrel (75 mg./plant), Ethrel (150 mg./plant), Azauracil, and Ethymylcyclohexanol. The chemicals were applied just after topping by spraying over the top of the plant with a fine-mist spray on July 29, 1968.

Filling capacity, a measure of volume-weight, for the bright and tip grades was determined. This served as an indicator of ability of the tobacco

from these treatments to fill cigarettes and is a desirable characteristic of Maryland tobacco. Total nitrogen and total alkaloid contents were determined in the laboratory.

Results

The filling capacity of the bright grades of tobacco was unaffected by the various growth regulators studied as shown in Table 1. The tip grades which come from the top of the plant are most likely to be affected in maturity and ripeness were changed in filling capacity. Tobacco treated with ethrel, azauracil, and 50 mg. of 2,4-D per plant were lower in filling capacity than the control treatment.

Table 1. also presents the effect of these chemical growth regulators on total nitrogen and total alkaloids. Maryland leaf is noted for its mild and neutral flavor and values of total nitrogen and alkaloids should be relatively low. The control treatment was the lowest in total nitrogen. Succinic acid, giberellic acid, 2,4-D (50 mg. per plant), 2,4-D (100 mg. per plant), ethrel (75 mg. per plant), ethrel (150 mg. per plant), azauracil and ethymylcyclohexanol resulted in significantly higher total nitrogen contents. The control was an intermediate position among the various treatments in effect on total alkaloids. General trends indicated benzyl adenine and the 2,4-D treatments to result in leaf with lower alkaloid levels. Succinic acid, azauracil and ethrel (75 mg. per plant) treatments were higher in total alkaloids.

Summary

The filling capacity of tip grades of tobacco was reduced by treatments of the chemical growth regulators; ethrel, azauracil and 50 mg. of 2,4-D per plant. None of the chemicals tested improved the total nitrogen content of the cured leaf. Benzyladenine and the 2,4-D treatments resulted in leaf with lower alkaloid levels whereas treatments of succinic acid, azauracil and 75 mg. of ethrel per plant were higher in total alkaloids.

Table 1. Effect of various chemical growth regulators on total nitrogen, total alkaloids and filling capacity of Maryland tobacco. 1968.

Treatment	% Total N	% Total Alkaloids	Filling Capacity cc/gm. Bright Grade	Filling Capacity cc/gm. Tip Grade
1. Giberellic Acid	1.92	1.56	7.53	7.13
2. Benzyl Adenine	1.71	1.31	7.63	7.23
3. Dimethyl Amino Succinic Acid	1.97	1.97	7.30	7.30
4. 2,4-D (50 mg./plant)	1.93	1.66	7.07	6.80
5. 2,4-D (100 mg./plant)	2.15	1.70	7.40	7.67
6. 2,4,5-T (50 mg./plant)	1.84	1.45	7.17	7.17
7. 2,4,5-T (100 mg./plant)	1.72	1.31	8.03	8.00
8. Ethrel (75 mg./plant)	1.89	1.89	7.50	7.03
9. Ethrel (150 mg./plant)	1.88	1.59	7.47	6.97
10. Azauracil	1.95	1.87	7.47	6.90
11. Ethymylcyclohexanol	1.96	1.61	7.20	7.07
12. Control	1.65	1.60	7.60	7.60
L.S.D. (05)	0.147	.387	N.S.	0.55
(01)	0.199	.526	--	--
C.V.	5.3%	16.2%	4.3%	5.2%

Some Physio-Chemical Relationships of Maryland Tobacco with Respect to Cultural, Fertilization Practices and Genetic Origin

J. H. Hoyert
Department of Agronomy

Purpose and Objectives

The acceptability of Maryland tobacco to the cigarette industry depends to a large degree on the unique physio-chemical properties of the leaf. These properties are due to climatic and soil factors, to genetic material, and finally to fertilization, curing and fermentation practices.

A shift in preference toward tobacco of lower alkaloid content has resulted from the current controversy on smoking and health. Likewise, the tobacco trade has found that more than a trace of nornicotine results in a bitter tasting smoke. A lower content of total nitrogen is also desirable. All three factors can be controlled by selection within genetic material, but persistent testing and screening must be practiced.

The objective was to determine the effect of various agronomic practices on the chemical composition and smoke constituents of Maryland tobacco.

Procedures

Approximately 100 representative samples of cured tobacco from the 1968 crop were obtained from growers in the 5-county Southern Maryland area. These were tested in the laboratory for total nitrogen content and total alkaloids which would be primarily the nicotine content. The objective of this study was to determine seasonal effects on these important chemical constituents by comparing to crops sampled in like manner during previous years.

Results

The 1968 crop was marked by relatively low total nitrogen and total alkaloid contents. The average total nitrogen was 2.17 per cent compared to over 3 percent in 1966, a year of dry weather, and total alkaloids averaged

2.64 per cent compared to over 4 per cent in the 1966 crop. The 1968 samples compared favorably to the excellent 1967 samples which ranged from 1.74 to 3.30 per cent for total nitrogen. The 1968 samples ranged from 1.17 to 3.33 per cent total nitrogen. Data from 1968 indicated a range of 1.13 to 4.01 per cent for total alkaloids whereas this range varied from 0.99 to 3.66 per cent in the 1967 samples.

Summary

The 1968 crop as represented by sampling technique described herein was shown to be of excellent balance in content of total nitrogen and total alkaloids. Total nitrogen averaged 2.17 per cent and total alkaloids averaged 2.64 per cent.

Tobacco Topping Studies

C. G. McKee
Department of Agronomy

Purpose and Objectives

1. To investigate the potential of chemicals for topping Maryland tobacco. Contact-type chemicals have long been used for sucker control in the tobacco area. If a contact acting chemical can be satisfactorily used to kill the flower bud, it would save one operation that is now carried out by hand.
2. To study the effects of various hand topping methods on the yield, quality, chemical content and physical characteristics of Maryland tobacco. Topping practices can influence time of ripening and the uniformity of the cured plants. Low, early topping could be used to gain an extra week of harvesting thus spreading out labor. More uniformity of the cured plants will speed stripping and grading and would be better adapted to mechanization.

Procedure

1. The chemical-topping studies were conducted in cooperation with the USDA. The experiment was set up in 1968 with three treatments: chemical topping using 1-decanol, hand topping with chemical sucker control using T-148 and hand topping with hand sucker removal. A Maryland Mammouth variety was used in this test because of the ease of killing the bud with chemicals. Maryland Mammouth variety will not bloom in the normal growing season and remain in the vegetative state.

The topping treatments were applied at 5 different stages of plant growth: 12, 18, 24, 30 and 36 leaf stages. The topping treatments were applied when the plant reached the desired number of leaves and were then harvested 10 days later.

2. Methods of Hand Topping

Earlier work indicated some advantages to low topping in that the tobacco could be harvested earlier and grading was easier because there were fewer sorts to be made. A study was started in 1967 testing 3 methods of low topping height compared with 3 methods of medium or normal topping height. Treatments tested were:

Treat. No.	Topping height	Topping time
	Low - 13 leaves harvested	early - before flower
2	Low - 13 leaves harvested	allow to flower & break down
3	Low - 13 leaves harvested	bud top and re-top
4	Medium - 18 leaves harvested	before flower
5	Medium - 18 leaves harvested	at flower
6	Medium - 18 leaves harvested	

Results

1. The 1968 results are summarized in Table 1. The Maryland Mammouth variety performed satisfactorily in the field and the chemical topping treatment worked very satisfactorily, however, the overall quality of the cured leaf was so low that it was considered not acceptable by Maryland standards. There were significant differences in both yield per acre and price per pound, but they counteracted each other and the result was no significant difference in average dollar return per acre.

2. Methods of Hand Topping

The results for the 1968 methods of hand topping test are given in Table 2. The low top treatments, 1, 2 and 3, were significantly lower in yield than the medium top treatments, 4, 5 and 6. Treatment 1, low top - early, gave the highest yield per acre, price per pound and dollar return per acre of the three low topping treatments, however it had the lowest filling capacity and highest content of total alkaloids -- both undesirable characteristics. The low topping treatments were harvested 10 days earlier than the medium topping treatments, but they averaged $252 less in acre value.

Summary

The results from the 1968 chemical topping study indicate that 1-decanol can be satisfactorily used to kill the terminal bud and thus "top" the tobacco. However, the quality of the Maryland Mammouth cured leaf was so inferior to normal Maryland varieties that the use of this variety was not considered practical.

The results from the 1968 hand topping test indicate that tobacco cannot be topped at a low leaf number without suffering considerable loss in both yield and dollar return. These results are completely contrary to the 1967 results where there were no significant differences between treatments. This indicates that there are great seasonal differences depending largely on rainfall moisture conditions in the latter part of the growing season.

Table 1. Chemical Topping, 1968 -- Maryland

	Yield/Acre	$/cwt.	$/Acre	Filling Capacity cc/gram
Chemical Top	1850	50	908	7.1
Hand Top + Chem. Sucker	1794	52	916	6.9
Hand Top + Hand Sucker	1611	53	845	6.8
L.S.D. .05	59	2	---	---
.01	80	-	---	---
12 leaves harvested	1441	59	845	6.7
18 leaves harvested	1573	55	870	6.9
24 leaves harvested	1764	54	951	6.7
30 leaves harvested	1977	45	885	7.1
36 leaves harvested	2003	45	897	7.2
L.S.D. .05	117	4	---	---
.01	168	5	---	---
Average	1751	51	889	6.9

Table 2. Results of experiments on various methods of hand topping.

Treatment	Yield Lbs/Acre	$/Cwt.	$/Acre	% Total Nitrogen	% Total Alkaloids	Filling Capacity cc/gram
1	1746	78	1360	3.02	2.53	5.4
2	1708	74	1271	2.98	1.92	5.9
3	1654	72	1196	2.66	1.61	6.4
4	1936	79	1535	2.25	2.03	6.8
5	1965	77	1517	2.49	1.96	6.3
6	2005	76	1531	2.31	1.90	6.4
L.S.D. .05	129	4	132	.52	.52	.5
.01	177		183	.72	.72	.8

Irrigation with Maryland Tobacco

C. G. McKee
Department of Agronomy

Purpose and Objectives

Previous research has indicated that the investment in irrigation equipment can be justified on most tobacco producing farms in Southern Maryland. The number of acres of tobacco that is presently irrigated is still relatively small -- 10 to 15% of the total, but it is increasing every year. Previous work also indicated that some varieties respond differently than others to higher nitrogen levels when adequate moisture is available.

The objective of this research is to determine the differential response of the released Maryland varieties and advanced breeding lines to nitrogen levels under optimum soil moisture conditions.

Procedures

The experiment was a split-split-plot design. Main plots were irrigation vs. no irrigation. The first split was nitrogen rate -- 70 and 100 pounds per acre and the second split was variety -- Catterton, Md. 64, Md. 59, Md. 609, Md. 10 and breeding line 102. There were four replicates for a total of 96 plots.

The experiment was located at the University of Maryland Tobacco Experimental Farm. The soil was Monmouth loamy fine sand. The initial fertilizer application of 60 lbs. nitrogen, 120 lbs. P_2O_5 and 180 lbs. K_2O was broadcast and disked in prior to planting. The additional nitrogen necessary was applied as a sidedressing 2 weeks after transplanting.

Water was applied to the plots requiring irrigation when tensiometers set at 6-8" were reading 50 or above and the plants were showing slight wilting in the heat of the day. A Skinner irrigation system was used that applied approximately 1/4 inch of water per hour.

Results

The 1969 season was very dry from transplanting until late July. These irrigations were applied for a total of 4 inches of water. Rainfall in late July and August was very heavy resulting in very rapid growth of the non-irrigated tobacco.

The irrigated plots matured and were harvested 10 days ahead of the non-irrigated plots.

The results for 1969 are summarized in Table 1. Md. 59 and Md. 609 showed little response to either nitrogen or irrigation in this season. Catterton and Md. 10 had a higher price per pound with irrigation at the higher nitrogen rate, but no response to irrigation at the lower nitrogen rate. Md. 64 and BL 102 were both much lower in average price per pound at the high nitrogen level without irrigation.

Summary

This was the first year for this test and it is apparent from the results that the test should be conducted for a number of years to get meaningful information. This test will be continued in 1970.

Table 1. Summary of the Irrigation Test with Tobacco -- 1969.

Yield -- Pounds/Acre

Variety	Irrigated		Non-Irrigated	
	Low N	High N	Low N	High N
Catterton	1459	1567	1480	1545
Md. 64	1917	2031	1820	1994
Md. 59	1510	1593	1603	1649
Md. 609	1668	1709	1628	1726
BL 102	1891	1960	1758	1788
Md. 10	1507	1614	1534	1640

Average Price/Pound -- Cents

Variety	Irrigated		Non-Irrigated	
	Low N	High N	Low N	High N
Catterton	62.46	67.58	59.36	59.14
Md. 64	54.30	53.88	63.40	44.97
Md. 59	69.25	67.64	66.94	64.18
Md. 609	68.60	66.63	69.34	66.84
BL 102	53.81	50.14	56.73	44.28
Md. 10	61.40	66.68	61.04	56.60

Dollars/Acre

Variety	Irrigated		Non-Irrigated	
	Low N	High N	Low N	High N
Catterton	911	1060	873	915
Md. 64	1026	1085	1155	901
Md. 59	1048	1079	1073	1055
Md. 609	1146	1144	1125	1153
BL 102	1017	983	980	800
Md. 10	923	1080	938	922

Nutsedge Control in Corn with Butylate, Atrazine, and Alachlor

J. V. Parochetti
Department of Agronomy

Purpose and Objectives

Nutsedge has become a serious perennial weed problem in corn. Atrazine (AAtrex) postemergence has not always resulted in acceptable control, probably due to one or more of the following reasons: (1) application after nutsedge had obtained resistance with advancing age, (2) rate per acre not sufficient, or (3) the species was purple nutsedge (southern) which is resistant.

In the past two years, butylate (Sutan) and butylate plus atrazine have resulted in good to excellent nutsedge control.

The objective was to continue experiments with butylate and butylate plus atrazine for nutsedge control. In addition, alachlor (Lasso) was also evaluated.

Procedures

Corn was planted April 28, 1969, at the Wye Institute, Queenstown, Maryland, in an area heavily infested with yellow nutsedge. Butylate at 2,3 and 4 lb/A, alachlor at 1.5, 2 and 4 lb/A, and atrazine at 1, 2 and 4 lb/A, were preplant incorporated (ppi) on April 28. Atrazine was applied preemergence on April 29 and postemergent treatments (with and without Sun 11E oil) were made on May 22 when corn was at the fifth leaf stage, nutsedge was 1.5 inches tall and grassy weeds were 1.5 inches tall.

Results

In discussing the nutsedge control results only the July 7 observation date will be used since this date is the most severe test date for herbicides.

Atrazine preplant incorporated (ppi) at 4 lb/A resulted in 60% nutsedge control and was approximately 20% better than 4 lb/A preemergence (Table 1). Atrazine postemergence resulted in approximately 50% control of nutsedge.

Butylate at 4 lb/A resulted in 50% nutsedge control; nutsedge control from 2 and 3 lb/A rates was 38 and 50%.

Nutsedge control from alachlor preplant incorporated at 1.5, 2, and 4 lb/A was 65, 63, and 83% respectively. The best combination was butylate 3 lb/A ppi plus atrazine 1 lb/A with Sun 11E oil which resulted in 85% nutsedge control. Butylate (3 lb/A) plus atrazine (1 lb/A) both ppi resulted in 70% nutsedge control.

Other weeds in the test were foxtail and fall panicum. Considering only the June 16 date for foxtail, good foxtail control was observed with atrazine 2 and 4 lb/A pre, atrazine 4 lb/A ppi, alachlor 4 lb/A ppi, butylate 4 lb/A ppi, and all combinations of butylate plus atrazine. Good to excellent fall panicum control was observed on September 22 with all combinations of butylate plus atrazine, butylate 4 lb/A ppi and all rates of alachlor.

Table 1. The effect of Atrazine, Butylate, and Lasso for nutsedge, foxtail and fall panicum control.

Treatment	Rate lb/A	Time of Application	Percent Weed Control: Foxtail 6/3	Foxtail 6/17	Nutsedge 6/3	Nutsedge 6/17	Nutsedge 7/2	Fall Panicum 9/22	Corn bu/A lb/A
1. Control	-	---	0	0	0	0	0	0	74.3
2. Atrazine	1	ppi	98	43	23	23	38	40	120.1
3. Atrazine	2	ppi	99	48	36	26	38	55	112.4
4. Atrazine	4	ppi	100	80	64	65	60	70	108.5
5. Atrazine	2	pre	96	85	58	68	43	60	110.9
6. Atrazine	4	pre	100	88	56	55	38	75	125.8
7. Butylate	2	ppi	93	70	58	55	38	75	110.1
8. Butylate	3	ppi	91	70	68	65	58	78	123.8
9. Butylate	4	ppi	100	88	60	63	50	88	104.9
10. Atrazine	1	post	43	45	61	60	35	13	115.6
11. Atrazine	2	post	48	43	61	65	53	0	118.7
12. Atrazine	4	post	69	50	61	63	50	10	110.0
13. Atrazine+11E oil	1	post	92	73	40	40	40	18	116.8
14. Atrazine+11E oil	2	post	85	58	56	43	40	18	116.7
15. Atrazine+11E oil	4	post	94	88	70	65	53	30	126.4
16. Butylate & Atrazine	3&1	ppi&post	98	100	84	75	55	95	133.5
17. Butylate & Atrazine+11E oil	3&1	ppi&post	98	98	90	83	85	95	121.5
18. Butylate	1&3	ppi&ppi	96	80	71	73	70	80	128.3
19. Atrazine & Butylate	1&4	ppi&ppi	98	88	78	78	83	83	120.1
20. Atrazine & Butylate	2&3	ppi&ppi	98	83	74	70	65	85	121.7
21. Atrazine & Butylat e	2&4	ppi&ppi	98	85	74	73	70	98	120.5
22. Atrazine & Butylate	2&2	ppi&ppi	100	88	58	65	68	83	102.4
23. Lasso	1.5	ppi	95	68	40	63	65	95	107.5
24. Lasso	2	ppi	93	70	59	63	63	95	107.2
25. Lasso	4	ppi	99	80	90	85	83	98	132.9
26. Cultivated Control			100	43	100	68	—	0	117.3

$LSD_{0.05}=22.5$

$LSD_{0.01}=29.9$

Postemergence Weed Control in corn with Combinations of Atrazine, oil, and Phytotoxic Herbicides

J. V. Parochetti
Department of Agronomy

Purpose and Objectives

Preemergent application of herbicides for weed control in corn, generally results in better grassy weed control and subsequently higher corn yields than postemergent applications. However, growers are sometimes faced with the necessity of treating corn postemergence if unfavorable climatic conditions follow corn planting. Considerable research has been conducted on the use of herbicides postemergence in corn with and without adjuvants. However, little emphasis has been given to combinations of herbicides for overall postemergent application. Recently, Minnesota workers reported that a combination of atrazine, dalapon, and a phytobland oil applied as an overall early postemergence successfully controlled foxtail without causing corn injury.

Field observations in 1968 of Maryland growers indicated that an overall postemergence combination of atrazine (1 lb/A) and linuron at approximately 0.25 lb/A resulted in excellent grassy weed control and no corn injury. However, where the spray pattern overlapped, considerable corn injury resulted.

The objective of this study was to test combinations of atrazine, phytobland oil, and phytotoxic herbicides at reduced rates for giant foxtail (Setaria faberii Herrm.) control.

Procedures

The experiment was located at the Wye Institute, near Queenstown, Maryland. The soil was Mattapex loam, containing 47% silt, 18% clay, 35% sand, and 1.5% organic matter. Pioneer 3304 corn was planted April 28, 1969, at 21,500 plants per acre. The land was fertilized for maximum production

according to the soil test report. The experimental design was a randomized complete block with four replications. Four row plots were 30 feet long and row width was 2.5 feet. The cultivated control was cultivated once on June 1; all other treatments were not cultivated.

All postemergence applications were made at 30 gpa with water. Treatments are listed in Table 1. Sun oil 11E was used at 3% (v:v). The early postemergent treatment was applied May 22, 24 days after planting. Plant height of foxtail and corn was 1.5 and 4 inches respectively. The late postemergent treatment was applied June 1, 33 days after planting corn when the height of foxtail and corn was 5 and 12 inches respectively.

Percent weed control was rated visually from zero to 100, with zero equalling no control and 100 equalling 100% control. A rating of 70 or higher was equivalent to commercially acceptable control and weeds could be removed by cultivation at this weed population. Percent vigor reduction was rated from zero to 100 with zero equalling no injury and 100 equalling 100% crop reduction. A rating of 30 or higher was designated as commercially unacceptable crop injury.

Results

Weed control, crop injury and yield data are presented in Table 1. Best foxtail control and highest corn yields were obtained with the early postemergent application except for atrazine and dalapon. No late postemergent treatment resulted in acceptable weed control, and as a result, corn yields were markedly reduced when compared to the early postemergence. The best foxtail control was with early postemergent application of atrazine + dalapon at 1 + 1/2 lb/A plus 3% (v:v) oil. However, this combination without oil resulted in inferior weed control with significantly lowered corn yields.

Corn injury was noted only with an early postemergent application of atrazine + linuron and atrazine + C 6313. However, the yields from these two treatments were not reduced.

Summary

The use of atrazine plus dalapon at 1 + 1/2 lb/A applied as a post-emergent treatment did not injure the corn when applied early to 4 in. corn. However, giant foxtail was controlled only when in early growth stage (1.5 in. high). Late postemergent treatment when foxtail was 5 inches tall resulted in poor control. Overall postemergent combinations of atrazine plus C 6313 and atrazine plus linuron were injurious to 4 in. corn but not to 12 in. corn. However, weed control from the early application, although injurious to the corn, did not reduce corn yields. Poor weed control in the late applications reduced corn yields.

Table 1. The effect of mixtures of atrazine, oil, and phytotoxic herbicides, on corn and giant foxtail, Wye Institute, Queenstown, Maryland.

Treatment	Rate lb/A	Corn Vigor[1] 5/28	Corn Vigor[1] 6/17	Giant Foxtail Control[2] 5/28	Giant Foxtail Control[2] 6/17	Giant Foxtail Control[2] 7/2	Yield Bu/A
Control	-	0 b	0 b	0 c	0 c	0 e	8.6 a[5]
Control, cultivated	-	0 b	0 b	0 c	70 a	88 a	74.3 de
Early Postemergence[3]							
Atrazine+Dalapon+Oil	1+1/2+3% v:v	0 b	0 b	92 a	88 a	88 a	89.5 e
Atrazine+Dalapon	1+1/2	0 b	0 b	55 b	70 a	65 b	69.6 cde
Atrazine+Linuron	1+1/4	25 a	15 a	92 a	78 a	68 b	99.9 e
Atrazine+C 6313	1+1/2	20 a	13 a	94 a	80 a	60 bc	81.5 e
Late Postemergence[4]							
Atrazine+Dalapon+Oil	1+1/2+3% v:v	-	10 ab	0 c	25 b	40 d	39.6 bc
Atrazine+Dalapon	1+1/2	-	10 ab	0 c	23 b	43 cd	29.5 ab
Atrazine+Linuron	1+1/4	-	0 b	0 c	23 b	8 e	43.4 bcd
Atrazine+C 6313	1+1/2	-	0 b	0 c	23 b	10 e	47.7 bcd

[1] Visual observations based on a scale of 0=no injury; 100=100% crop destruction.

[2] Visual observations based on a scale of 0=no control; 100=100% control.

[3] Treated May 22, 1969, 24 days after planting; foxtail 1.5 in. high; corn 4 in. high.

[4] Yield values within a column followed by identical letters are not significant at the 0.05 level of probability.

Johnsongrass Control in Field Scale and Experimental Plots at the Wye Institute

J. V. Parochetti
Department of Agronomy and the Wye Institute Cooperating

Purpose and Objectives

Johnsongrass is rapidly becoming a major pest in Maryland, especially on the Eastern Shore. This noxious weed had infested a major portion of a field at the Wye Institute. A concerted effort was undertaken in 1969 to control the spread of this weed and to eliminate it from the farm. In order to evaluate different control measures, an experiment consisting of 11 treatments was conducted in a very heavily infested portion of the field. The remainder of the field was used as a large scale demonstration with 3 treatments currently recommended by the University of Maryland for Johnsongrass control in soybeans.

Procedures

Field Scale Program. Actively growing johnsongrass, 14 to 16 inches tall, was treated with 5 lb/A dalapon (Dowpon) on May 27, 1969. After several days the land was disked and trifluralin (Treflan), vernolate (Vernam), and nitralin (Planavin) were preplant incorporated. Two cultivations were employed and escaping johnsongrass was spot sprayed with Glytac.

Experimental Plots. Two experiments, replicated at least three times, were established in a part of the field uniformly infested with johnsongrass. One experiment was to assess the effectiveness of herbicide combinations and cultivation for the control of johnsongrass in soybeans. These treatments are listed in Table 1. The other experiment was to evaluate the comparative value of three summer fallow tillage practices using the disk, the spring tooth, and the power rotortiller.

Results

In the field scale program, it was visually estimated that between 50+70% of the johnsongrass rhizomes were controlled by the preplow, foliar applied dalapon. The preplant incorporated herbicides gave good seedling johnsongrass control early in the season. It appears that the best treatment was the combination of dalapon + trifluralin. Cultivation was necessary for johnsongrass emerging from viable rhizome pieces as well as late germinating seedlings. Soybean yields were excellent, approximately 40 bu/A. The long range effects of this demonstration must await future growing seasons in order to evaluate the effectiveness of this program.

In the experiment which included similar treatments as the field scale program, the best treatment was dalapon + trifluralin (Treflan) and one cultivation. This combination effected 96.8% control (Table 1). One cultivation and dalapon + nitralin (Planavin) or dalapon + vernolate (Vernam) resulted in good johnsongrass control. In every case, one cultivation increased johnsongrass control. When tilling the land 8 separate times before incorporating the herbicides, trifluralin, and nitralin resulted in good johnsongrass control (Table 1).

The other experiment evaluated three tillage practices, for the control of johnsongrass by a summer fallow program. Tillage was done every 9 to 14 days starting in mid-May. At the end of August, almost 100% rhizome kill was noted for each tillage practice. Similar results were obtained in 1968. Therefore, it may be concluded that each tillage practice is effective for johnsongrass control, provided that the tillage is done every 9 to 14 days.

Summary

Rhizomatous johnsongrass area was eradicated from a heavily infested area by employing a fallow tillage program every 9 to 14 days; equally

effective were the spring tooth, disk, or rotortiller.

In soybean production, best johnsongrass control resulted from the combination of cultivation and split applications of dalapon applied to preplow foliar johnsongrass plus either trifluralin, nitralin or vernolate applied preplant incorporated.

Table 1. Johnsongrass Control in Soybean Production at the Wye Institute. 1969.

Treatment	lb/A[3]	% Johnsongrass Control[5]		Soybean Bu/A	
		Cult.[4]	Not Cult.	Cult.	Not Cult.
Control	---	44.9	0 (31.4)[6]	12.8	9.0
Dalapon	5 ppw	73.6	54.7	22.0	13.6
Trifluralin	1 ppi	66.9	49.4	22.0	14.0
Nitralin	1 ppi	70.1	45.2	26.9	16.5
Vernolate	3 ppi	50.3	3.2	13.3	9.6
Dalapon + [1] Trifluralin	5 ppw + 1 ppi	96.8	84.7	35.2	30.2
Dalapon + [1] Nitralin	5 ppw + 1 ppi	90.8	77.4	32.4	26.9
Dalapon + [1] Vernolate	5 ppw + 3 ppi	86.9	79.0	27.4	25.0
Trifluralin[2]	1 ppi	89.5	77.7	28.1	27.7
Nitralin[2]	1 ppi	88.5	70.1	39.9	23.9
Vernolate[2]	3 ppi	77.1	49.7	29.0	18.5

[1] Dalapon applied with 1 (one) pint of Adjuvan-T/25 gal. water.

[2] Received 8 tillages before herbicides were applied.

[3] Preplow (ppw) applied May 28th to 12" to 14" actively growing grass. Preplant incorporated (ppi) herbicides applied June 18th.

[4] One cultivation done fifth week following planting.

[5] % control based on the fresh weight of Johnsongrass harvested September, 1969.

[6] Fresh weight in lb. of Johnsongrass per 95 sq. ft. of the untreated control, not cultivated.

Giant Foxtail and Fall Panicum Control in Soybeans

J. V. Parochetti
Department of Agronomy

Purpose and Objectives

Several herbicides are used in Maryland for annual grass control in soybeans. Growers seek information regarding the most effective herbicide available. This experiment was conducted to determine the potential of several herbicides for controlling weeds in soybeans.

Procedures

Two experiments were conducted at the Wye Institute, near Queenstown, Maryland. Each plot consisted of four 20 foot rows, spaced 2.5 feet apart. A completely randomized block design was used with four replications. All treatments were applied in 30 gpa of water.

In both experiments Cutler soybeans were planted on June 4. Preemergent treatments were applied June 4 and preplant incorporated treatments were applied June 3. Experiment A was infested primarily with giant foxtail (*Setaria faberil* Hermm.) and was located on Mattapex silt loam. Treatments are listed in Table 1. Experiment B was heavily infested with fall panicum (*Panicum dichotomiflorum* Michx.) and was located on Bertie silt loam. Treatments are listed in Table 2.

Results

No soybean injury was recorded for any treatments. Soybean yields were taken only in experiment A; the highest rate of each herbicide except dinoseb resulted in a significant yield increase (Table 1). However, this yield increase cannot be attributed to foxtail control because several lower rates of alachlor resulted in excellent foxtail control with no subsequent yield increase. Annual morningglory (*Ipomea* spp.) infestation was sporatic and mav

thus have effected yields.

Best foxtail control was obtained with alachlor (Table 1). For comparable foxtail control approximately twice as much Linuron was necessary. At the rates studied, dinoseb (Dinitro) did not control foxtail and the methyl ester of amiben at 3 lb/A resulted in poor foxtail control.

In experiment B, excellent full-season fall panicum control was effected by 3 lb/A of C 6989 (Preforam) and diphenamide plus dinoseb at 2.0 + 1.5 lb/A. Combinations provided good to excellent early season fall panicum control, but failed to provide adequate control at the end of the growing season: (Trifluralin, linuron and amiben (methyl ester + norea)). Fair fall panicum control was experienced with naptalam + dinoseb (Dyanap) and amiben (methyl ester).

Summary

Excellent giant foxtail control resulted with all rates of alachlor used. C 6313 was needed at twice the rate of linuron for comparable giant foxtail control. Good to excellent full season fall panicum control resulted from C 6989 and a combination of diphenamide + dinoseb.

Table 1. Experiment A: Preemergence foxtail control in soybeans.

Treatment	Rate lb/A	% Control[1/] Foxtail 7/2	Soybean Yield Bu/A
Control	--	0 e[2/]	31.3 ab
Control-cultivated	--	65 bc	34.3 abc
Alachlor	1.0	93 ab	33.0 abc
Alachlor	1.5	98 a	30.8 ab
Alachlor	2.0	95 a	44.3 c
Linuron	0.5	70 abc	35.7 abc
Linuron	0.75	83 ab	36.0 bc
Dinoseb	3.0	8 d	24.1 a
Amiben (methyl ester)	3.0	48 c	41.5 bc
C 6313	0.75	65 bc	32.7 abc
C 6313	1.0	73 abc	34.7 abc
C 6313	1.5	86 ab	44.0 c

[1/] Visual observations based on a scale of 0=no control; 100=100% control.

[2/] Values within a column followed by identical letters are not significant at the 0.05 level of probability.

Table 2. Experiment B: Fall panicum control resulting from several preemergent herbicides in soybeans.

Treatment	Rate lb/A	Fall Panicum Control [1] 7/2 %	Fall Panicum Control [1] 10/17 %
Control	--	0 c [2]	0 c
Cultivated Control	--	98 a	80 ab
Trifluralin	.75	93 ab	65 ab
Linuron	.75	85 ab	35 bc
Naptalam + Dinoseb	2.0 + 1.0	78 b	53 ab
C 6989	3.0	90 ab	95 a
Diphenamide + Dinoseb	2.0 + 1.5	88 ab	88 a
Amiben + Norea	1.0 + 0.8	88 ab	53 ab
Amiben + Norea	1.5 + 1.2	98 a	55 ab
Amiben	3.0	78 b	35 bc

[1] Visual observations based on a scale of 0=no injury; 100=100% weed control.

[2] Values within a column followed by identical letters are not significant at the 0.05 level of probability.

Chickweed Control in Dormant Alfalfa

J. V. Parochetti
Department of Agronomy

Purpose and Objectives

Chickweed (*Stellaria media* L. Cyrillo) is a major winter weed problem in alfalfa (*Medicago sativa* L.) in Maryland. Chickweed growth can become so dense that stands may be reduced and proper cutting and field curing are not possible, thus lowering the quality of the hay. This paper reports three experiments conducted in three different years with various chemicals for the control of chickweed.

Procedures

The experimental work was conducted on dormant Williamsburg alfalfa-orchardgrass (*Dactylis glomerata* L.) growing on a Hagerstown loam predominantly infested with common chickweed. All locations had been established at least one full year. Herbicides were applied as a spray (30 gpa) and as a dry material (impregnated on granular fertilizer carrier).

Chickweed control was recorded as an estimate of the percentage of ground not covered by chickweed. Alfalfa and orchardgrass injury was recorded on a scale of zero (0) to 100 with zero equalling no effect on the crop and 100 equalling 100% destruction; a rating of 30 or higher was considered unacceptable injury. All yields are expressed on an oven-dry basis.

Herbicides applied as a spray were simazine, GS 14254, diuron, chloropropham, dinoseb, dichlobenil, terbacil, and RH 315. Herbicides that were impregnated on fertilizer were simazine, GS 14254, diuron and chloropropham. Treatments were applied February 28, 1969, near Wilson, Maryland. The experimental design was a randomized complete block with three replications. All plots received 724 lb/A of 0-10-30 fertilizer.

Results

Simazine and GS 14254 applied as a spray at 0.8 lb/A resulted in excellent (90% or better) control of chickweed, whereas, inferior control resulted from 0.8 lb/A of sprayed diuron. At 1.6 lb/A, these three herbicides provided excellent chickweed control. Chickweed control, resulting from simazine and GS 14254 impregnated on fertilizer at 0.8 lb/A at the early observation date (April 19), was about 10% less than the 0.8 lb/A spray application. However, at the late date of observation of the chickweed, the impregnated fertilizer applications were comparable to the sprayed applications. The 1.6 lb/A simazine and GS 14254 impregnated fertilizer application provided excellent chickweed control; similar to the 1.6 lb/A sprayed application. Diuron on fertilizer provided inferior chickweed control probably due to the late application date of February 28 (Table 1).

The only significant increase from the check in alfalfa-grass yields was an increase resulting from 0.8 lb/A of simazine impregnated on fertilizer. At the 0.01 level of probability, there were no differences from the check and further yields were not taken.

Terbacil at 0.4 lb/A resulted in excellent chickweed control, but completely eliminated the orchardgrass. RH 315 at 2 lb/A and chloropropham at 1 lb/A effected similar chickweed control which increased from fair to excellent control from April 19 to the April 30 observation. At the rates studied, dinoseb and dichlobenil were not effective chickweed herbicides.

Summary

In 1969, late winter applications of the lower rate of sprayed and fertilizer impregnated simazine and GS 14254 were superior to the same rate of diuron. Diuron and chloropropham impregnated fertilizer applied in the fall resulted in excellent chickweed control.

In general, none of the treatments significantly affected total alfalfa-grass yields; terbacil, although not reducing total forage yields, was the only herbicide to completely eliminate orchardgrass.

Table 1. Chickweed control in established dormant alfalfa, 1969, Washington County, Maryland with herbicides applied as spray applications and on impregnated 0-10-30 fertilizer.

Treatment	Herbicide Carrier	Herbicide Rate	Chickweed Control[1] 4/19	Chickweed Control[1] 4/30	Dry matter yields Orchardgrass + Alfalfa 5/14
		lb/A	%	%	T/A
Check	---	---	0.0 e[2]	0.0 d	.88
Diuron	Spray	0.8	55.0 bc	76.7 ab	1.10
Diuron	Spray	1.6	93.3 a	100.0 a	.98
Diuron	Fertilizer	0.8	13.3 e	20.0 cd	.97
Diuron	Fertilizer	1.6	41.7 cd	56.7 b	.74
Simazine	Spray	0.8	86.7 a	98.3 a	.98
Simazine	Spray	1.6	93.3 a	100.0 a	1.05
Simazine	Fertilizer	0.8	81.7 ab	98.3 a	1.15
Simazine	Fertilizer	1.6	95.0 a	100.0 a	.75
GS 14254	Spray	0.8	90.0 a	98.3 a	1.09
GS 14254	Spray	1.6	98.3 a	100.0 a	1.05
GS 14254	Fertilizer	0.8	78.3 ab	95.0 a	1.05
GS 14254	Fertilizer	1.6	98.3	100.0 a	.92
Dichlobenil	Spray	1.0	16.7 de	6.7 cd	1.05
Terbacil	Spray	0.4	96.7 a	100.0 a	.99
Terbacil	Spray	0.8	100.0 a	100.0 a	.91
RH 315	Spray	1.0	55.0 bc	75.0 ab	84
RH 315	Spray	2.0	78.3 ab	93.3 a	1.08
Chloropropham	Spray	1.0	75.0 ab	96.7 a	1.06
Dinoseb	Spray	2.0	46.7 c	28.3 c	1.02
				LSD 0.05=	.26

[1] Visual ratings of the percentage of the ground not covered by chickweed; 0=ground covered with chickweed, no control; 100=100% chickweed free.

[2] Values within a column followed by identical letters are not significantly different at the 0.05 level of probability.

Breeding and Evaluation of Kentucky Bluegrass for Turf

A. J. Powell
Department of Agronomy

Purpose and Objectives

New Kentucky Bluegrass varieties appear on the market each year. Many are imported or obtained from the northern U.S. or Canada. These varieties are seldom adapted to this area. Other new varieties, which could be adapted, are being developed by regional experiment stations and should be tested throughout the region before being released. The homeowner and sod producer needs to know which of the numerous varieties are best adapted to his area. Also in this experiment, new methods of turf evaluation are being investigated.

Procedures

Forty-two Kentucky bluegrass clones (see Table 1) were seeded in fall of 1968. Two additional clones were added as sod during fall of 1969. The basic experiment located at the Plant Research Farm includes all forty-four varieties, fertilized at 3 lbs. N/1000 sq. ft./year, and mowed at 1.5-inch mowing height. In order to establish a mowing height response, a similar experiment was established and mowed at 2.5 inches. This was also located at the Plant Research Farm but due to a shortage of seed, seven of the original 44 varieties were not included. This experiment was also duplicated at the Princeton Turf Farms, Centreville, Maryland. All experiments included 3 replications and were evaluated monthly for color, density and overall quality. Due to equipment failure, it was not possible to use the "Ratiospect" as an evaluation tool. The two sodded varieties were not evaluated.

Results

Density -- As would be expected, density improved throughout the year for all varieties but even one year after establishment, some varieties had

not completely filled in. Some differences that appeared in early spring were probably a result of a poor seed source. Many varieties were very slow to establish but gave 100% cover by fall. Windsor, Merion, Fylking, Belturf and K8-146 gave superior density throughout the year at all locations. Southport and three New Jersey Experimentals; P-56, P-114, and P-5; gave poor density and resulted in less than the 100% cover that would be normal one year after establishment. Newport, South Dakota Certified, Prato, PSU-107, and K8-145 gave very good density at only two locations.

Color -- Color is only an aesthetic evaluation but the darker green color is desired by the homeowner. None of the more common varieties rated high in color at all locations. Arista, Sodco and New Jersey Experimentals P-56 and P-114 rated best in color. Nuggett, Pennstar, Fylking, WK-412, New Jersey Experimental P-5 and Pennsylvania State University K-107 rated high in color at two locations. Palouse, Geary and Kenblue resulted in poor color at all three locations. It is interesting to note that the New Jersey Experimentals that rated best in color, gave poorest density ratings.

Quality -- Quality is the overall appearance including some emphasis on color and density but basically the coarseness, erectness and variability among plants. Those giving best quality ratings at all locations were South Dakota Certified, Fylking, K8-146, K8-145 and a mixture including Fylking, Pennstar and Merion. At two locations Newport, Prato, WK-411, WK-412 and K8-144 gave very good quality ratings. Southport and New Jersey Experimental P-5 gave poor quality ratings at all locations and Cougar, Geary, Sodco and New Jersey Experimental P-56 resulted in poor quality ratings at two locations.

Disease -- Ratings were taken during August to assess which varieties were more resistant to the Dollar Spot -- Helminthosporium infestations which occurred at that time. The New Jersey Experimentals seemed highly resistant. Considering the other results, these varieties were most likely selected for their disease resistance and color. Fylking, Merion, Kenblue and Belturf also were resistant. Delta, K8-145, Prato and Nuggett were highly susceptible to the disease complex.

Those tests which were mowed at 2.5 inches were not severely diseased.

Summary

It is very difficult to evaluate 44 varieties at three locations and determine which varieties performed best. In Table 1, an attempt has been made to summarize this first year's results by giving a plus to those varieties which performed best according to location and evaluation made and a minus to varieties which gave poor performance. Approximately 1/3 of the 44 varieties were selected for each category; however, especially for density ratings, more than 1/3 of the varieties were included since a breaking point between ratings was not obvious.

Using this method, the same weight is given to density, color and quality. The disease ratings were also included to give a possible $\pm$ 10 points. Overall performance, according to total points, is given in Table 2. Using this method with data from only the first year's results, it would seem likely that those varieties with a negative performance are not well adapted to this area.

Table 1. Performance of 44 Kentucky bluegrass varieties according to evaluation method and location. Pluses and minuses indicate superior or inferior performance.

Variety	Density Location* 1	2	3	Quality Location 1	2	3	Color Location 1	2	3	Disease Location 1	Total Points
Newport		+	+		+	+	-			+	+4
Ba 6124 (Scott)	+	-	-		-		+			+	0
Windsor	+	+	+				-	-		-	0
S. Dakota Cert.	+	+		+	+	+			-		+4
Arista	+	-		+			+	+	+	-	+3
Southport	-	-	-	-	-	-					-6
Nuggett	-	-			-			+	+	-	-2
Palouse	+	+	-		-		-	-	-		-3
A-34 (Warren)	+	-	+		-	+	-		-	+	0
Pennstar	+	-	-	+		-	+	+		-	0
Cougar	-	-	+	-	-		-		+	-	-4
Park		+	-		+	-	-		-		-2
Geary			-		-	-	-	-	-		-6
S-21 (Jacklin)		+				-	-	-			-2
Fylking (0217)	+	+	+	+	+	+	+	+		+	+9
Merion	+	+	+	+	+	-				+	+5
Delta			+	-	-	+	-	-		-	-3
Prato		+	+	+		+	-			-	+2
WK-408 (Weibulls)	+		+			-	-	-			-1
WK-411 (Weibulls)		+		+	+			+			+4
WK-412 (Weibulls)	+	+			+	+	+	+		-	+5
Minn-6						-			-	-	-3
Sodco	+	-	-		-	-	+	+	+	+	+1
Primo		+		-	+	-	-		-	+	-1
Kenblue	-	+	+			+	-	-	-	+	0
Belturf	+	+	+		-	+			+	+	+5
NJE P-56	-	-	-		-	-	+	+	+	+	-1
NJE P-114	-	-	-		-		+	+	+	+	0
NJE P-5	-	-	-	-	-	-	+	+		+	-3
NJE P-35**	-			-			+			+	0
NJE P-69**	-			-			+			+	0
NJE P-115**	+			+							+2
R.I. PP-1	+	-				+			+	+	+3
PSU K-107	+	+		+			+	+		+	+6
Zwartberg**	+			+						-	+1
Campus**				+			+				+2
PSU K-162**	+						-			+	+1
PSU K-128**	-						+				0
K8-146	+	+	+	+	+	+			+		+7
K8-145	+	+		+	+	+			+	-	+5
K8-144		+		+		+			+	-	+3
Merion + Fylking + Pennstar	+			+	+	+		+			+5

* Location: 1. $1\frac{1}{2}$" cut, Plant Research Farm, 2. $2\frac{1}{2}$" cut, Plant Research Farm, 3. $2\frac{1}{2}$" cut, Princeton Turf Farms.

** These varieties were only included at Location 1 and total points may not be indicative of their performance.

Table 2. Overall rating of 44 Kentucky bluegrass clones.

+9 - Fylking	0 - Windsor
+7 - K8-146	0 - A-34
+6 - PSU K-107	0 - Pennstar
+5 - Mix (Fylking, Pennstar and Merion)	0 - Kenblue
+5 - Merion	0 - NJE P-114
+5 - WK 412	0 - NJE P-35*
+5 - Belturf	0 - NJE P-69*
+5 - K8-145	0 - PSU K-128*
+4 - Newport	-1 - WK-408
+4 - S. Dakota Certified	-1 - Primo
+4 - WK 411	-1 - NJE P-56
+3 - Arista	-2 - Nuggett
+3 - R.I. PP-1	-2 - Park
+3 - K8-144	-2 - S-21
+2 - Prato	-3 - Palouse
+2 - NJE P-115*	-3 - Delta
+2 - Campus*	-3 - Minn-6
+1 - Sodco	-3 - NJE P-5
+1 - Zwartberg*	-4 - Cougar
+1 - PSU K-162*	-6 - Geary
0 - Ba 6124	-6 - Southport

* Only one location.

Effectiveness and Residual Properties of Several Herbicides Used in Turfgrass Areas

A. J. Powell
Department of Agronomy

Purpose and Objectives

As preemergence control of crabgrass becomes more popular, the residual effects of repeated applications must be investigated. Also, control of crabgrass as associated with injury to desirable species must be studied since few new preemergence herbicides are being released. The purpose of this study was to determine the herbicide effectiveness as related to yearly or less often applications and to study the ill-effects of repeated applications of these materials on the desirable turfgrasses.

Procedures

A Kentucky bluegrass-red fescue turf which was planted in 1965 at the University of Maryland Plant Research Farm, has been treated yearly with several commercially available and experimental herbicides. To increase crabgrass infestations and persistence, the turf has been maintained at a 1 inch height of cut, under low fertility (2 lb. N/1000 sq. ft./year), and overseeded yearly with crabgrass.

During this 4-year period, several chemicals have been ineffective and dropped from the experiment. Listed in Table 1 are the commercially available herbicides which have been used yearly and the recommended or suggested rate as used. Quadrate counts and visual estimates were made of the weed control. Visual estimates were also made of turf quality, turf injury and broadleaf weed control.

Results

The 1969 results are listed in Table 1 except for results obtained from the residual effect of chemicals applied yearly but not commercially avail-

able. In reviewing these results, one must understand that an injurious effect may carry over to the following year(s). That is, the turf will not fully recover to normal density. The herbicide formulation is very important and should be noted in each case.

After four yearly applications of bensulide g and ec, tricalcium arsenate g, and DCPA wp, crabgrass control was excellent. All chemicals used gave satisfactory but not complete crabgrass control.

Since broadleaf weeds are often associated with a close mowed, crabgrass infested turf, it was important to determine the effectiveness of herbicides in controlling these annual weeds that may germinate throughout the year. It was noted that all plots contained some clover. Tricalcium arsenate gave best broadleaf weed control but bensulide g and siduron wp gave near equal control. Azak, bandane, and benefin gave poorest control.

Percent turf cover shows injurious effects of the herbicides after yearly applications. These results do not show a residual buildup that would destroy all bluegrass. However, near 50% of the established turf has been lost on the tricalcium arsenate treated plots. Bensulide g, siduron wp and DCPA wp resulted in best turf cover. Percent turf cover does not include the dead crabgrass present at time of rating. Bandane g also caused considerable turf injury and resulted in a 60% turf cover and a very thatchy, shallow-rooted turf.

Overall turf quality (appearance, percent turf cover, crabgrass and broadleaf weed control) was best with bensulide g and tupersan. Because of turf injury, quality was poor with tricalcium arsenate and bandane.

As indicated in Table 1 selected herbicides were applied for two years only and results were obtained the following year to determine the residual

carryover and the ability of the turf to recover. However, good crabgrass control or turf injury may not be due to residual effects of the herbicide. Considering all evaluations, bensulide was superior to bandane and azak. These two herbicides again showed considerable turf injury as compared to bensulide.

Summary

These results substantiate present Maryland recommendations and do not indicate that chemical residue carryover in subsequent years will continue to injure turf. Bensulide, DCPA and siduron were superior in these trials but the formulations were important. The wettable powder form of siduron and dacthal and the granular form of bensulide were superior. Because of serious turf injury and lack of turf quality, bandane, azak and tricalcium arsenate should not be used for crabgrass control on bluegrass.

Table 1. Turf response and crabgrass control with preemergence herbicides applied yearly. Data recorded in November, 1969 and presented as a mean of 4 replications.

Herbicide Formulation[1]	Rate lb/A	% Crabgrass Control Estimate	Quadrate Count[2]	Broadleaf Weeds[3]	Turf Cover %	Turf Quality[4]
Herbicides applied yearly for four years.						
Bandane g	1	91.25	96.9	4.75	60.00	3.75
Benefin g	2	90.75	79.2	5.00	61.25	4.75
Bensulide g	5	97.50	100.0	6.25	83.50	6.50
Bensulide ec	6	97.25	95.8	5.25	60.00	5.25
DCPA g	12	81.25	58.9	5.75	70.00	5.50
DCPA wp	13	97.50	100.0	5.25	78.75	5.50
Terbutrol g	19	89.25	78.1	5.00	67.50	5.50
Terbutrol wp	20	90.50	70.8	4.75	58.75	5.50
Tricalcium arsenate g	26	98.25	100.0	8.25	51.25	2.75
Siduron g	29	91.00	55.2	5.50	72.50	6.00
Siduron wp	30	91.75	81.8	6.25	82.50	5.75
Check		25.63	0	6.38	32.5	3.75
Herbicides applied only in spring of 1967 and 1968.						
Bandane g	4	95.25	99.48	4.75	66.25	5.25
Betasan ec	7	95.50	90.1	5.25	85.00	6.00
Betasan g	11	92.50	78.65	4.75	70.00	5.75
Azak g	21	60.00	9.90	5.25	53.75	4.50
Azak g	22	87.25	71.86	5.25	66.25	5.50

[1] Formulation: g = granular, ec = emulsifiable concentrate, wp = wettable powder.

[2] Quadrate counts: Percent of 48 quadrates (6" x 6")/plot with no crabgrass plants.

[3] Rating Scale: 10 = no weeds, best control, 1 = highest weed content.

[4] Rating Scale: 10 = normal or best, 1 = poor quality.

Tufcote Bermudagrass - Adaptations and Requirements for Turf Uses

A. J. Powell
Department of Agronomy

Purpose and Objectives

Tufcote bermudagrass (Cynodon dactylon, L.) is becoming very popular and known as a tough, wear-resistant turf. It is also winterhardy, requires minimum maintenance except during summer, and is somewhat resistant to most insect and disease problems that occur on bluegrass lawns in Maryland. Tufcote is ideal for summer use areas and is gaining much popularity on golf course tees and fairways and home lawns. With these varied uses, it is very important to understand its behavior under extreme management practices. These experiments were designed to study turf quality and persistence in order to: establish optimum fertilization techniques and mowing procedures; determine which cool-season grasses are best suited for overseeding Tufcote during fall in order to mask its dormancy; and determine the effects of heavy nitrogen fertilization and close mowing on survival and quality of Tufcote and certain overseeded species.

Procedures

Experiment A, Fertilization. Three forms of nitrogen were applied at different rates and at different dates during the summer months. Forms of nitrogen included a quickly available source (urea), a slowly available synthetic organic source (ureaformaldehyde) and a slowly available natural organic source (processed organic wastes, Agrinite). Rates were 3 to 9 lbs. N/1000 sq. ft. per year in single and multiple applications.

Experiment B, Overseeding. Annual and perennial cool-season turf species were overseeded into bermuda turf in the fall. Grasses included annual ryegrass, annual bluegrass, Pennlawn red fescue, Ky-31 tall fescue,

Merion Kentucky bluegrass and redtop, these were seeded at two rates with mowing heights of 1 and 2 inches. Two plots were not seeded and one of these plots was not verticut. (Verticutting bermuda prior to overseeding is necessary for good soil-seed contact.)

Experiment C, Mowing. Visual ratings were taken periodically on color, density and quality. The "Ratiospect" method to measure color or quality was not effective due to continuous mechanical problems.

Results

Experiment A, Fertiiization. High rates of N (up to 9 lbs. N/1000 sq. ft.) had no effect upon winter survival even when applied as late as September. Monthly applications of urea at 1 lb. N/1000 sq. ft. gave excellent color and quality throughout the growing season. Heavier but less frequent applications resulted in a rapid growth response that usually resulted in scalping injury. Also, the turf suffered from insufficient nitrogen after $1\frac{1}{2}$ to 2 months following fertilization. Bimonthly applications of ureaformaldehyde and the natural organic also resulted in high quality turf but when the same amount of N was applied in one application in April, quality was inferior by June. High rates of all sources (6 lbs. N/year) when applied monthly or bimonthly caused excessive summer growth and greatly increased the mowing frequency necessary to prevent scalping. Density differences among treatments were not obvious except when scalping occurred.

Experiment B, Overseeding. This study was complicated due to a late fall overseeding and severe winter. Germination was abnormal except with the ryegrass which germinated quickly and had excellent seeding vigor. Some germination was noted with all species but many were completely masked when the bermuda broke dormancy during spring. Annual bluegrass, Pennlawn

red fescue and redtop did not persist in sufficient quantity to be rated. At the 2-inch mowing height Merion Kentucky bluegrass was rated best throughout the summer and was responsible for 25% of the ground cover after bermuda dormancy. A thin stand of tall fescue (5% of ground cover) survived the summer but did not blend well with the Tufcote and low quality ratings resulted. For fall and winter cover and color, annual ryegrass was superior and disappeared in early summer as expected. Turf quality was not severely affected during the transition from ryegrass back to bermuda. Only Merion remained throughout the summer at the 1-inch height of cut, however, density was poor and spotted.

Experiment C, Mowing. Tufcote bermuda mowed $\frac{1}{2}$ or 1 inch high and cut 2 or 3 times per week continues to produce better quality turf than when mowed at $1\frac{1}{2}$-inch and cut less frequently. Especially during a high rainfall period in August, mowing every other day was necessary to prevent scalping. The 1.5-inch height of cut usually resulted in lower quality ratings due to an uneven-cut appearance and the buildup of dead organic material within the sod. When mowed weekly or biweekly at 1.5 inches, the turf appeared to be scalped throughout the season but this did not affect density of live plants.

Summary

In order to maintain color and quality, monthly applications of a soluble nitrogen source or bimonthly applications of an organic source are necessary. When higher rates than one lb. N/1000 sq. ft. are used, mowing frequency becomes very important due to scalping injury. In any case, Tufcote should be mowed 1 inch high and 2 or 3 times per week. This is contrary to general opinion of homeowners who believe that Tufcote is a low maintenance turf even during summer.

Concerning overseeding Tufcote for winter color and cover, Kentucky bluegrass was most desirable and would not necessarily have to be reseeded each year since it does survive the summer. However, the height of cut must be raised to 2 inches to favor the cool-season grass. If the 1-inch height of cut is desired then annual ryegrass would give best winter color and cover but the overseeding operation must be repeated each fall. Due to its coarseness, tall fescue as the overseeded specie does not blend well with the Tufcote.

Breeding for Drought Tolerant Corn Hybrids

R. G. Rothgeb
Department of Agronomy

Purpose and Objectives

Although corn continues to be Maryland's major grain crop and has shown an upward trend in yield per acre in recent years, it is limited in productivity by local or extensive drought almost every year. There is reason to believe that drought losses could be lessened by use of hybrids that can tolerate drought without sacrifice in the seasonable years. Specific objectives are as follows:

1. To obtain genetic improvement in drought tolerance in dent corn.
2. To perfect a nursery method for comparing hybrids in a test split for soil moisture restriction and supplementary irrigation.

Procedures

In 1969, two field experiments contributing to this project were conducted -- one at the University of Maryland Plant Research Farm (2nd year), and the other at the Wye Institute Farm. The research farm test involved 16 open pedigree hybrids all planted May 27 with 4 randomized plots for each hybrid in each main treatment - moisture restriction and supplementary irrigation. Therefore, the total number of plots was 128. Each unit plot was one 40-inch row x 9-1/3 ft. long to support a perfect stand of 16 plants.

Moisture restriction was obtained by fitting black polyethylene plastic sheeting around the plants to divert rainfall down slope off the planted area. Plastic placement was made about 10 days prior to the beginning of the corn tasseling stage.

Rainfall was supplemented by the use of sprinkler hoses placed between rows in the irrigated section. All hoses were adjusted for slow, uniform delivery. Irrigation was done in time to prevent moisture stress in the absence of rainfall.

Results

Unusual rainfall distribution and quantity in 1969 prevented development of any moisture stress in the experiment. Not only did the plastic go down on wet soil but rainy weather thereafter reduced loss through evaporation and transpiration. The result was good productivity over both treatments. Yield for treatment was not significantly different, but yield variance for hybrids was significant. Good data on comparative maturity of test entries were obtained.

In contrast to the 1969 season the 1968 season provided good stress data for this project. In 1968 the stress treatment limited the average test yield to 51 bu/A or only 56% of the average for supplemental irrigation. Also, 5 entries showed significant superiority under moisture restriction.

Response of Corn to Irrigation as Affected by Moisture Deficit, Age of Plants, and Hybrid

R. G. Rothgeb
Department of Agronomy

Purpose and Objectives

Lack of adequate moisture during the growth period of corn in Maryland is a frequent cause for low yields. In situations where water for irrigation is available at permissible cost, rainfall deficiency can be supplemented in this way. This experiment is designed to provide useful data as to the timeliness of irrigation on Mattapex Silt Loam soil. (Wye Institute Farm):

1. To determine what effect time of planting at this location may have on the need and effectiveness of irrigation.
2. To relate the development of stress to weather conditions.
3. To determine whether hybrids differ significantly in need for irrigation.

Procedures

Initially the experiment was planned to extend over several seasons. Each year 6 hybrids representing 3 maturity groups were to be compared. Any hybrid showing inferior performance was to be replaced the following year.

Starting about May 1 four complete plantings of the 6 hybrids were to be made at intervals of 10 to 14 days, depending on weather conditions. Each planting of 6 hybrids was to be split for (a) supplemental irrigation and (b) rainfall only. The irrigated block was serviced by four stationary overhead rotary distributors. The no-irrigation plot was located just out of range of the irrigation system. Irrigations were made as judged necessary to avoid plant stress.

Prior to the first planting date, 700 lbs./A of a 16-8-8 fertilizer was plowed down on both treatment blocks. For each planting date the seed bed was freshly prepared and 200 lbs./A 8-16-16 fertilizer was applied side-row with the planter. Seed planting was done by hand in the 30-inch planter rows.

On each planting date and treatment block each hybrid was planted in 4 replicate plots each 3 rows wide x 15 ft. long (1/387 acre). Approximately 60 seeds were planted per plot.

Results

A 33-day drought extending from June 19 to July 23 with a total of only 1.19 inches of rain, apparently resulted in consistent response to two irrigations (0.6" July 7 and 0.6" July 14) for the April 30 and May 15 plantings. The silking periods for these two plantings were July 7-19 and July 19-25. Heavy rain, beginning July 23, made irrigation unnecessary for the last two plantings.

Average Yields for Six Hybrids for First Two Dates

Hybrid	Irrigated Bu/A	No Ir. Bu/A	Dif. Bu/A
DeKalb XL45	99.8	73.8	26.0
WF9 X Oh43	90.9	75.8	15.1
Pioneer 3306	145.8	114.3	31.5
HSSRf x Oh43Rf	131.5	91.6	39.9
Cribfiller 66	97.6	67.7	29.9
38-11 x C103Rf	48.6	17.9	30.7

High-Lysine (Opaque 2) Corn Field Tests - 1969

R. G. Rothgeb
Department of Agronomy

Purpose and Objectives

There continues to be interest in Maryland as to the use of high-lysine (02) corn in poultry and swine rations. The use of this type of corn depends upon its comparative effectiveness in feed rations as well as its cost as a source of the amino acids, lysine and tryptophan. From the corn growers' viewpoint it must compete favorably as to net monetary returns obtainable from normal dent corn. For the purpose of providing comparative field-performance data, tests were made in 1969.

Procedures

Two field tests were conducted - one on the Plant Research Farm, and the other on the Wye Institute Farm. In both tests each hybrid was hand-planted on 4 replicate plots (plot size - 2 (30" rows) x 15 ft.) at a seeding rate of approximately 23,000 seeds per acre.

Planting date: Research Farm - May 27, Wye Farm, May 29. Both tests were on uniform loam soils receiving fertilizer P/A approximately as follows:

Plow down - 700 lbs. 16-8-8; planter - 300 lbs. 5-10-10. The 16 hybrids entered in the tests were provided by sources as follows:

Entry 1 - Illinois Foundation Seeds, Inc.

Entries 2 through 9 - Pioneer Hi-Bred Corn Company. In this group each H. lysine entry is paired with an isogenic normal which was detasseled.

Entries 10 through 13 - U. of Illinois Expt. Station.

Double-cross H. lysine experimental hybrids-

entries 14, 15, 16 by company as indicated.

Results

Entry No.		Yield - Grain 12% H_2O Wye Bu/A	Yield - Grain 12% H_2O P. Res. Bu/A	Test Wt. Wye lbs.	Test Wt. P. Res. lbs.	Loss due to Kernel Damage Wye %	Loss due to Kernel Damage P. Res. %
1	3-way lysine	76	56	51.3	50.5	-	13.0
2	P.* A. Nor.	90	107	53.0	55.0	-	1.9
3	P. A. Ly.	76	86	46.5	47.0	-	4.8
4	P. B. Nor.	109	105	56.5	58.0	-	2.5
5	P. B. Ly.	91	75	50.0	51.0	-	7.9
6	P. 3376 Nor.	90	99	50.5	53.0	10.3	9.8
7	P. 3376 Ly.	70	80	43.5	46.0	16.1	11.9
8	P. 3306 Nor.	93	125	52.0	56.0	4.8	4.1
9	P. 3306 Ly.	75	78	46.5	49.0	11.2	7.6
10	Ill. (1) Ly.	53	38	46.0	47.0	13.4	12.5
11	Ill. (2) Ly.	33	33	47.3	50.0	8.8	6.0
12	Ill. (3) Ly.	46	41	47.0	50.0	13.1	11.8
13	Ill. (4) Ly.	56	41	48.0	50.0	11.0	12.7
14	Trojan Tx102	49	38	49.0	49.5	11.4	24.0
15	Trojan TxS102	63	56	49.0	50.0	9.1	11.4
16	Cargill 880S	--	64	--	51.5		9.8
Av. (1-15)		71.3	70.5	49.1	50.8	10.9	11.1
LSD_5		15.1	17.0				

4 pairs N-LY Comparison	Bu/A Av.		Lbs.	Lbs.	%
Av. Normal	95.4	109.0	53.0	55.5	4.6
Av. Lysine	78.0	79.8	46.6	48.3	8.6
Difference	17.4	29.2	6.4	7.1	-4.0
Loss	18%	27%			

*P = Pioneer

Note: Much ear-worm damage at both locations.

Summary

1. As indicated by yields of the normal entries in the two tests yields were low.
2. Test weights for the normal entries were below 56 in 5 of 8 comparisons for normals.
3. Kernel damage by insects and follow-up kernel mold was high for most entries, but the lysine entries averaged about double the loss of the normals.
4. Late planting and moisture stress at times may have helped to limit yield.
5. The two test locations checked very well.
6. It would appear that better 02 hybrids are needed to cope with growth conditions such as occurred in these two tests.

Varietal Improvement in Wheat and Barley

R. G. Rothgeb
Department of Agronomy

Purpose and Objectives

Soft red winter wheat and winter barley continue to be important farm crops in Maryland as indicated by their respective state acreages in 1969 -- 117,000 for wheat and 99,000 for barley. Heavier use of fertilizer on both crops and the trend toward double-cropping with barley are important considerations in improvement.

Procedures

1. Continued cooperation with USDA and state experiment stations in conducting uniform nurseries for wheat and barley.
2. Conduct nurseries and plot tests on high fertility levels.
3. Crosses involving Norin-10 derivatives such as Blueboy will be compared for yield, test weight and consistency of performance.

In 1969, useful data were obtained from uniform nurseries and from field-plot tests on the University of Maryland Plant Research Farm as follows:

1. Nurseries - barley winter hardiness, barly nursery for semi-hardy varieties, eastern soft wheat and southern soft wheat nurseries.
2. Four-replicate 75th acre field plot tests for barley and wheat respectively.
3. Response of Blueboy wheat to 4 levels of nitrogen topdressing.

All testing was done on Beltsville silt loam soil adjusted to pH 6.0-6.5 and with a lbs./acre application at planting of approximately 20N-35P-66K. All tests received a minimum of 40 lbs. N. topdressing in the spring.

Results

In the wheat nurseries only one entry out-yielded Blueboy and none had significantly less lodging.

With 63 bu/A Blueboy was high in the field-plot test, with Arthur second at 59.1 bu/A. In this test all 13 entries including Blueboy lodged badly with 40 lbs. nitrogen topdressed, and in adjacent tests it did not respond to rates above 40 lbs. Apparently, carry-over nitrogen was significant.

Although Blueboy was productive it was handicapped by low test weight and a high proportion of small kernels.

Development of Soybean Varieties with Responsiveness to High Fertility

J. A. Schillinger
Department of Agronomy

Purpose and Objectives

Soybean varieties are notorious for their inability to respond to added phosphorus and potassium. However, farmers that produce consistent high yields of soybeans usually maintain a good fertility program throughout their rotation.

The primary objectives of this study are to isolate soybean genotypes that will produce high yields consistently when grown in presence of high levels of either P, K, or P + K and to identify reasons for differences in response. These genotypes then would be utilized in soybean breeding programs with the eventual result being new soybean varieties for Maryland with improved ability to respond economically to P and K applications.

Procedures

Over 800 genotypes of soybeans were screened under field conditions for their ability to respond to high levels of P, K, and P + K. In 1969, 80 genotypes selected as responders in 1968 were retested in 4 fertility blocks where the fertility varied as follows:

Block	pH	Mg	P_2O_5	K_2O
NF (Check)	6.2	186H[1]	95M	60L
K	6.2	202H	110M	318VH
PK	6.2	160H	245H	306VH
P	6.1	140H	200H	66L

[1] Pounds per acre of available magnesium, phosphate, or potash as extracted by 1:1 mixture of 0.05 NHCl and 0.025 NH_2SO_4. H = high, M = medium, and L = low range.

Each entry was planted in a 16 foot row and was replicated three times in each block. Response was measured as increase in yield in K, PK, and P blocks over yields in NF block for each entry.

Results

Genetic variability was found for response to P, K and P + K among 80 genotypes of soybeans evaluated in 1969. Data for 1968-69 are presented in Table 1 for the top responding soybean genotypes. Data from 1969 should be more accurate because of an additional replication, larger plot size, greater differentials in fertility level in each block and fewer genotypes on which to collect data.

Greatest response to P, K, and P + K was common among those genotypes with yields below the check variety, for example Kim and Osayo. However, some noteworthy exceptions were observed including Boone, Illington, and P165342. Genotypes were found that responded primarily to P and others were found that responded mainly to K. This trend in response was noted in both years in some genotypes i.e., P1157444, FC19979-7 and Illington.

Increases in seed size (grams/100 seeds) were noted for some genotypes when grown under conditions of high levels of P, K, and P + K (Table 2). These increases in seed size were associated with yield increases.

Summary

Soybean genotypes were found that gave significant response in yield to P, K, and P + K fertility. Response was not restricted to low yielding genotypes but was also observed in high yielding genotypes. An increase in seed size in some responding genotypes was also noted.

Table 1. Yield and % response of three soybean genotypes plus check variety for soybean maturity groups III, IV and V in 1968 and 1969. Wye Institute.

		Response to Phosphorus			
		1968		1969	
	Entry	Yield[1] Bu/A	% Response[2]	Yield[3] Bu/A	% Response[1]
Group III					
	Kim	56.4	132.7	36.0	137.4
	Lincoln	59.3	95.0	51.8	99.2
	Osayo	75.0	221.2	36.9	159.7
	54620-2	54.4	128.9	43.8	117.4
Group IV					
	Boone	55.8	114.3	58.4	119.9
	Perry	70.5	95.7	60.2	105.1
	31702	72.7	152.1	46.3	116.0
	71506	75.5	93.2	62.0	121.3
Group V					
	Dorman	63.9	86.5	42.3	63.9
	65342	94.8	106.0	52.0	148.6
	157430	70.9	174.2	52.5	120.7
	274422	72.2	124.1	66.5	175.9

[1] Yield was determined on a 3' untrimmed row.

[2] % of yield in NF block.

[3] Yield was determined on a 13' trimmed row.

Table 1. Yield and % response of three soybean genotypes plus check variety for soybean maturity groups III, IV and V in 1968 and 1969. Wye Institute. (Continued)

II

Response to Potassium

	Entry	1968 Yield[1] Bu/A	1968 % Response[2]	1969 Yield[3] Bu/A	1969 % Response[1]
Group III					
	Illington	61.9	136.4	57.5	130.1
	Kim	72.1	169.6	40.9	156.1
	Lincoln	58.2	93.3	56.6	108.4
	Osayo	52.6	155.2	39.6	171.4
Group IV					
	Boone	65.5	134.2	70.6	145.0
	Hokkaido	62.3	183.2	54.0	137.4
	Perry	73.7	114.1	53.8	93.9
	FC19979-7	64.3	131.5	55.1	138.8
Group V					
	Dorman	72.3	97.8	35.8	85.3
	P165342	109.5	122.5	45.5	130.0
	157430	63.1	155.0	57.2	131.5
	157444	70.9	118.4	49.8	139.9

[1] Yield was determined on a 3' untrimmed row.

[2] % of yield in NF block.

[3] Yield was determined on a 13' trimmed row.

Table 1. Yield and % response of three soybean genotypes plus check variety for soybean maturity groups III, IV and V in 1968 and 1969. Wye Institute. (Continued)

III

Response to Phosphorus and Potassium

	Entry	1968 Yield[1] Bu/A	1968 % Response[2]	1969 Yield[3] Bu/A	1969 % Response[1]
Group III					
	Kim	68.5	161.2	38.8	145.4
	Lincoln	57.4	92.0	55.0	105.4
	54620-2	62.4	147.9	49.0	131.4
	60272	73.2	147.6	49.3	134.7
Group IV					
	Boone	69.3	142.0	63.5	130.4
	Hokkaido	57.4	168.8	50.1	127.5
	Perry	76.1	103.3	51.2	89.4
	68679-2	70.7	134.2	57.0	149.6
Group V					
	Dorman	66.7	90.3	46.6	76.2
	157444	84.0	140.2	53.3	149.7
	157451	80.0	133.8	39.8	124.0
	181546	101.8	124.3	42.8	169.8

[1] Yield was determined on a 3' untrimmed row.

[2] % of yield in NF block.

[3] Yield was determined on a 13' trimmed row.

Table 2. Effect of fertility on seed size in selected soybean genotypes.

	Entry	Grams per 100 seed[1]			
		NF	K	PK	P
Group III					
	Kim	28.8	32.0	31.1	28.8
	Lincoln	16.7	17.1	16.4	16.4
Group IV					
	Hokkaido	22.2	25.0	27.7	26.0
	Perry	17.5	17.9	16.8	18.5
	P183858	16.7	20.6	18.5	18.4
Group V					
	P1157451	21.1	26.4	26.2	26.1
	Dorman	12.9	12.7	12.8	13.6

[1] Determined as average weight of 100 seed based on a 300 seed sample from each of three replications.

Alfalfa Variety Performance Evaluations

J. A. Schillinger
Department of Agronomy

Purpose and Objectives

Alfalfa is a major component of Maryland's forage production which supports the livestock enterprise of our state. In recent years, alfalfa has regained much of its popularity among growers, which was lost primarily due to the presence of the alfalfa weevil. The advent of new alfalfa varieties with resistance to the weevil has helped to bolster alfalfa's new image. Performance data on weevil resistant varieties and other new varieties is needed to insure their adaptability to Maryland.

Procedures

These studies were located on a Manor silt loam at the Forage Research Farm, Clarksville. Varieties were broadcast at a 16 lbs./A in 5 x 20 ft. plots. A randomized complete block design with 5 replications was used. Studies were seeded in April 1967 consisting of 5 varieties and April 1969 containing 20 varieties. Soil treatments prior to seeding included application of 1 ton of pulverized limestone, 500 lbs./A of 5-20-20 and Eptam at 4 lbs./A. Yields were taken on a 32 day harvest schedule.

Results

In the study seeded in April 1967, forage yields computed on basis of 12% moisture were significantly different at the 5% level of probability for 1969 (Table 1). "Team" alfalfa proved to be the outstanding variety in this test. Its superiority was associated with its resistance to several disease organisms, particularly Southern Anthracnose and common and Stemphylium leafspots. The depletion of stands as a result of these diseases attacking the alfalfa is also presented in Table 1.

Yields from three harvests taken during first year of the study established in April 1969 are presented in Table 2. In this test were 15 proprietary varieties, including two of the first released alfalfa hybrids (TX-1 and TX-2) from the Teweless Seed Co. Again as in 1967, anthracnose played an important role in limiting the yield of some varieties as is indicated by loss in stands between July and September (Table 2).

Summary

Alfalfa variety performance in Maryland was measured for twenty-one varieties in two studies. Yield and stand persistence were adversely affected by infections of anthracnose and leafspots. It is apparent from these studies that new alfalfa varieties for Maryland should include some resistance to these pests. Alfalfa weevil resistant varieties included in these tests were among the better yielding varieties even without the presence of the weevil in menacing numbers.

Table 1. Alfalfa hay yields and stand notes for alfalfa varieties established in April 1967 at Clarksville, Maryland.

Variety	Tons/Acre			Percent Stand	
	1967	1968	1969	7/67	7/69
Team	2.08	6.77	7.35	92	56
Cherokee	2.05	6.68	6.59	91	44
Saranac	2.06	6.38	6.28	94	38
Iroquois	1.93	6.27	6.34	88	33
Vernal	1.75	6.03	6.32	93	36
C.V. (%)	10.8	14.1	11.4	10.1	13.3
LSD .05	.07	.29	.19	8	9

Table 2. Performance of 20 alfalfa varieties in year of establishment, Clarksville, Maryland 1969.

Variety	Forage Yield Tons/Acre	% Stand July 9	% Stand September 11	% Stand Loss
Team	4.70	88	84	4
Iroquois	4.69	96	71	25
Saranac	4.61	93	83	10
ATRA 55	4.59	98	81	17
Weevlchek	4.54	95	84	11
WL306	4.53	100	97	3
WL305	4.49	100	92	8
ATRA 50	4.48	95	84	11
Dominor	4.44	97	83	14
Titan	4.43	96	88	8
Vernal	4.43	93	87	6
TX-2	4.41	96	80	16
N5-150A-1	4.40	93	83	10
Scout	4.39	93	82	11
Cayuga	4.36	94	83	11
TX-1	4.35	98	66	32
WL215	4.28	99	86	13
WL210	4.27	98	94	4
Promor	4.19	96	85	11
Tempo	4.16	95	93	2

Breeding and Evaluation of Soybean Genotypes and Blends

Grant Vest
Department of Agronomy, and Soybean Investigations,
Crops Research Division, U. S. Department of Agriculture,
Beltsville, Maryland

Purpose and Objectives

To obtain soybean varieties, adapted to the Mid-Atlantic states, which are superior to those varieties presently being grown in this area.

Procedures

By making the appropriate crosses, populations containing germ plasm for high yield and high protein are developed and maintained. Selections made from these populations are tested for yield, other agronomic characteristics and chemical composition.

During 1969 the Mid-Atlantic soybean workers decided to yield test lines developed in the Mid-Atlantic states. These Mid-Atlantic tests, prepared under the direction of Soybean Investigations, Beltsville, Md., were grown at Centerton and Adelphia, New Jersey; Georgetown, Delaware; Clarksville, Queenstown, Linkwood, and Snow Hill, Maryland; and at Warsaw, Va. Forty-eight lines of maturity groups IV (Clark, Cutler), IVS (Kent, Delmar), and V (Hill, York) were tested.

In addition many early generation lines were yield tested at Linkwood and Queenstown (Wye Institute). Uniform Group tests IV, IVS, V, VI and Uniform Preliminary Group tests, IV, IVS and V also were grown at both locations, and three blend tests were grown at Queenstown.

Results

The aforementioned tests were grown in order that the agronomic characteristics of these genotypes could be evaluated in Maryland. Primary emphasis was placed on yield, maturity date, lodging, seed size, and percentage of protein and oil. Six genotypes developed at Beltsville are now

being considered for the possible release within the next two years. Data on two of these genotypes are found in Tables 1 and 2.

The data in Table 1 show that in 1969, Md 63-3303-3 yielded as well as Cutler; however, this genotype is of the same maturity as Kent which it outyielded. The 1969 figure is a mean of seven tests conducted at five locations. Md 63-3303-3 has better seed quality, holds its seed longer and stands better than either Kent or Cutler. In 1969 two lines which seemed well adapted to the sandy soils and environment of the Eastern Shore were placed in tests at many locations. Md 62-2313 was placed into Uniform Group IVS tests. This line did not perform as well as it has in the past and will be dropped from our testing. For 4 years Md 62-3514 has appeared to be well adapted to the Eastern Shore. It was tested in 4 locations this year and although it did not perform exceptionally well this year when its past performance is evaluated this line stands out (Table 2). The reason that Md 62-3514 has not been released is that it has mixed pubescence. Pure lines derived from this genotype have not been tested sufficiently to evaluate their potential. Md 62-3514 has better seed holding than Kent, is 2-5 days later than Kent, and 3-5 days earlier than Delmar.

We have 3 lines of Group V maturity which we are testing extensively. These lines Md 64-338, Md 64-404 and Md 64-429 were all included in Uniform Preliminary Group V tests. All 3 lines performed quite satisfactorily. We hope that all three will be moved up to Uniform Test V this year. In addition Md 64-338 was tested in the Mid-Atlantic area at three locations. At these locations it yielded more than Hill, York, and Dare. Md 64-338 is of Hill maturity which places it between Delmar and Dare. This line stands well and may have some potential for the lower Eastern Shore.

The data of some of our high protein lines are summarized in Table 3. Some of the lines yield well and have good protein and oil, particularly those lines of IVS (Delmar) maturity.

A blend study conducted at the Wye Institute the past two years has given some interesting data which are summarized in Table 4. It appears that some blends will outyield the components that make up the blend. The blend of varieties A and B yielded 6.5 bushels above the average of A and B and 5.4 bushels above the highest component, A. It must be pointed out, however, that many blends not reported here yielded much less than the mean of the components and some yielded less than the lowest component. The studies with blends will continue.

Many plant rows were evaluated in 1969 and will be increased and tested in 1970. In addition many lines were selected from yield tests. These lines will be advanced in various tests in 1970.

Summary

The agronomic data for all lines grown in 1970 are being compiled and selection of superior genotypes will be made. I believe that some of these new selections will eventually be released as varieties for the Mid-Atlantic states.

Table 1. Maryland line of maturity Group IV being considered for future release.

	1966[1]	1967[2]	1968[3]	1969[4]	% Protein	% Oil
Md 63-3363-3	37.0	38.2	48.7	45.5	40.6	23.5
Clark	31.6	25.3	45.9	40.4	41.1	22.6
Cutler	--	40.0	48.5	45.8	42.2	22.0
Kent	--	--	--	42.5	41.5	21.5

[1]One location. [2]Two locations. [3]Three locations. [4]Five locations.

Table 2. Maryland soybean line Md 62-3514, maturity group IVS being considered for future release.

Genotype	1966[1]	1967[2]	1968[3]	1969[4]	$\bar{x}$	% Protein	% Oil
Md 62-3514	34.8	44.0	46.8	39.6	41.9	40.6	22.9
Cutler	25.9	40.2	48.5	--	41.9	41.1	23.1
Kent	--	--	--	39.9	39.9	41.2	22.6
Delmar	--	--	--	37.6	37.6	40.0	23.7

[1]One location. [2]Two locations. [3]Three locations. [4]Four locations.

Table 3. Maryland high protein lines.

	Queenstown & Linkwood 1967 & 1968			Queenstown 1969		
	% Protein	% Oil	Yield	% Protein	% Oil	Yield
Cutler	42.1	22.3	40.3	43.0	21.9	54.4
Md 65-1602	46.7	20.9	36.1	45.9	21.0	39.8
-3807	46.0	21.1	36.0	44.2	21.0	42.3
-2611	45.7	19.5	28.4	44.3	21.4	45.7
-1515	45.7	20.1	37.3	44.1	21.1	42.8
-3515	45.6	21.7	34.2	44.4	20.4	38.8
Delmar	41.2	22.3	36.7	41.4	22.8	44.7
Md 65-3802	46.5	19.5	29.7	44.4	19.5	44.0
-3714	45.8	20.1	31.7	45.3	19.8	47.3
-2403	45.1	20.0	36.2	46.5	20.0	48.7
-3412	44.4	20.1	34.3	44.2	20.4	44.7
-1702	44.3	21.2	35.7	42.6	21.0	40.1
-2303	--	--	--	44.0	21.5	59.8

Table 4. Yields of Blends. 1968 & 1969 Wye Institute.

Component	Year 1968	Year 1969	$\bar{x}$	Mean of Components	Blend $\bar{x}$ vs Components $\bar{x}$	Blend vs Highest Component $\bar{x}$
A	30.2	49.7	40.0			
B	27.9	42.7	37.8			
C	35.5	44.7	40.1			
D	30.0	36.1	33.0			
Blend						
A + B	38.4	52.3	45.4	38.9	+6.5	+5.4
A + C	39.1	49.7	44.4	40.0	+4.4	+4.3
A + D	29.6	46.6	38.1	36.5	+1.6	-1.9
B + C	36.3	41.1	38.7	39.0	-0.3	-1.4
B + D	28.3	45.5	36.9	35.4	+1.5	-0.9
C + D	32.0	48.0	40.0	36.6	+3.4	-0.1
Cutler	37.8	52.1	45.0			

The Blend A + B is 5-10 days later than Cutler.

Micronutrient Requirements of Corn on Important Maryland Soils

J. H. Axley
Department of Agronomy

Purpose and Objectives

The objectives of this study were:

1. To study deficient, optimum, and toxic levels of copper, boron, manganese, and zinc in corn.
2. To study interrelationships of these micronutrients with other elements in plant nutrition.

Procedures

Four field experiments were established, two in Worcester County and two in Prince George's County, on the University of Maryland Plant Research Farm. This year's experiments were concerned with the use of boron and zinc for corn production. The boron levels were 0, 0.5 and 1 lb./acre. The levels of zinc used were 0, 5 and 10 lbs./acre. All experiments were randomized block experiments replicated at least four times.

Results

Some of the corn in both of the Worcester County experiments exhibited zinc deficiency symptoms early in its growth period on the plots that had not been treated with zinc. However, when harvest season arrived, the yields on all plots were not significantly different. The Prince George's experiments were badly damaged by black birds both in the spring and fall.

Summary

Possibly the zinc deficient plants failed to grow properly as there were barren stalks in the plots. But the presence of a sufficient number of healthy plants in all plots resulted in the same yield for all treatments. These yields were in the neighborhood of 103 bu./acre to 112 bu./acre.

The Fate of Applied Fertilizer Nitrogen on Field Corn

J. H. Axley and J. O. Legg
Department of Agronomy and ARS, USDA

Purpose and Objectives

1. To determine the percent of applied nitrogen fertilizer taken up by corn plants.
2. To determine the amount of the applied nitrogen remaining in the soil at the end of the growing season.
3. To determine leaching losses of the applied nitrogen.

Procedures

One square foot of soil was fertilized with ^{15}N (tagged nitrogen) in 18' x 21' plots treated with 0, 30, 60, 90, 120, and 240 lbs. of nitrogen per acre. Randomized block experiment was replicated 4 times. It included two placement areas, one around a corn hill and the other between corn hills. Corn was check planted with hills on 3' centers. The soil used in this experiment was a Matapeake silt loam.

Results

The results of the ^{15}N analysis suggest that little nitrogen is lost by leaching. About 45% of the added N was taken up by the corn plants at a 30 lbs./acre rate of application and 28% of added N was taken up at a 240 lbs./acre rate of application.

Of the applied nitrogen, only about 60% could be accounted for after one year as some remained in the soil. It is postulated that much of this unaccounted for nitrogen was lost in the form of a gas. This study considered nitrogen applied around the plant and 1½' from the plant. When it was applied 1½' away from the corn, a slightly greater loss of nitrogen occurred than when it was applied next to the plant.

Summary

A unique method has been developed to use the very costly ^{15}N in field tests at great reductions in price. Studies of this nature will show, under field conditions, how much of the applied fertilizer N enters the plant, how much stays in the soil, and how much is lost.

The Development of Soil Tests for Determining "Available" Arsenic in Soils

J. H. Axley
Department of Agronomy

Arsenic compounds are still being used in agriculture. For this reason soils are being contaminated by arsenic.

Purpose and Objectives

1. To determine the chemical forms of arsenic in soils.
2. To develop, calibrate, and improve soil tests for determining the levels of available arsenic in soil.

Procedures

Procedure A

Two methods of determining total arsenic in soil were studied, a colorimetric arsenic-molybdate method and a dead-stop coulometric titration method with electrically generated iodine as the titrating agent. End point was detected biamperometrically by impressing 200 mv between two platinum foil electrodes with a polarograph.

Procedure B

Six methods of determining toxicity of arsenic in soils were investigated:

1. Total As -- 1 g of soil was digested in 6 ml of $HClO_4$ and H_2SO_4 acids, 1 to 1.
2. Easily soluble Fe, Al, and Ca forms of soil As (similar to Chang and Jackson method for P). The total of all three forms were used for correlations.
3. Same as #2 but with toxicity factors for each material. These factors were developed in this research. The total of such calculations were used for correlations.

4. As extracted by 0.05N HCl and 0.025N H_2SO_4.

5. As extracted by 0.5N $NaHCO_3$.

6. As extracted in soil with a pH of 6.5 or less by #4 method and for soil with pH above 6.5 with method #5.

Results

Procedure A

When the results of both systems were statistically analyzed, the two methods gave comparable results with equal accuracy and precision.

Procedure B

Correlation coefficients of the log of the As concentrations vs. biological toxicity gave:

r = .74 for method #1

r = .73 for method #2

r = .82 for method #3

r = .81 for method #4

r = .82 for method #5

r = .81 for method #6

Summary

Two methods, colorimetric and coulometric, for determining As concentrations were compared. Both were satisfactory for use in soils. Six methods of extracting toxic As from soils were studied and four methods were found to be good and with about the same reliability. One of the good methods is that used in the Maryland Soil Testing Laboratory for routine analyses of phosphorus, potassium, and magnesium.

Response of Corn to Monoammonium Phosphate (MAP) and to Ammonium Polyphosphate (APP) Using Several Different Methods of Placement

V. A. Bandel
Department of Agronomy

Purpose and Objectives

1. To compare the effectiveness of MAP and APP on corn yields and on rate of emergence.
2. To compare plant uptake of P from MAP and from APP at two stages of growth -- at 20 to 25 days after emergence and at the silking stage.
3. To compare the effectiveness of two corn fertilizers on yield, emergence and phosphorus uptake when plowed down, when placed in a band 2 inches to the side and 2 inches below the seed, or when placed in direct contact with the seed.

Procedures

A split-plot design was used in which phosphorus sources were the main plots and placement methods were the sub-plots. There were 2 phosphorus sources used (MAP and APP), 5 placement treatments, and a phosphorus check. With 5 replicates, there were a total of 60 plots with each measuring 15 by 50 feet. The treatments are listed in Table 1.

The plow-down fertilizer was applied April 9, 1969 and single cross hybrid (Pioneer 3306) was planted April 25 in 30 inch rows at an anticipated population of 18,000 plants per acre. The soil temperature at the 2-inch depth was 65° F. An E-Z Flow granular herbicide attachment on the planter was used to apply the pop-up fertilizer at the rate of 3-12-3. The corn was sidedressed with 75 lbs./A of nitrogen when 12 to 18 inches tall.

Atrazine and Sutan were applied as pre-emergence weed control.

The height of the corn plants was measured on June 16. Whole plant samples were taken in early June when the plants were 18 to 24 inches tall. Ear leaf samples were taken on July 23 at the tasseling stage. Grain yields were harvested and measured on September 26. The plant samples were analyzed for nitrogen, phosphorus, potassium, calcium, and magnesium.

Results

As in 1967 and 1968, rate of emergence was not noticeably affected by any of the treatments. But, from the time the corn was approximately 6 to 12 inches tall until early tasseling, the corn plants that had received some starter fertilizer in the row grew faster than those plants which had not received the starter fertilizer. The plant height on June 16 is given in Table 2.

In 1969 row fertilizer increased early corn growth only after no P was plowed down. Early growing conditions were more favorable in 1969 than in 1968, thus possibly accounting for the poorer early response to row fertilizer. In 1968 maximum early growth occurred when there was some fertilizer in the row, regardless of whether it was placed 1) in direct contact with the seed (pop-up), or 2) in the more conventional manner approximately 2 inches beside and 2 inches below the seed, or 3) in a combination of 1) and 2). The absence of plow-down phosphorus and no subsequent row fertilizer caused the most severe reduction in early growth. This severe reduction was essentially corrected by the "pop-up" treatment and the 1968 corn grew out of these visible differences by tasseling time. A soil test of the plot area indicated a high phosphorus level (165 H) which may account for the gradual elimination of differences in height between the treatments as root systems expanded and came into contact with more of the soil phosphorus.

Nitrogen, potassium, calcium, and magnesium levels in the whole plant and in the ear leaf were not significantly affected by treatment (Tables 3, 4, 5, and 6). As in 1968, P levels were significantly reduced in the whole plant when no phosphorus had been plowed down. A small amount of phosphorus in the row as "pop-up" did not increase the P level during early growth. But since pop-up did appear to increase early growth slightly, this may have been a dilution effect (Table 7). Similar trends in P uptake occurred in 1969 as in 1968. But relationships are not clear.

Neither fertilizer placement, nor P source had any significant effect upon grain yields in 1969 (Table 8) nor over the entire 3-year period (Table 9).

Summary

Under the conditions of this investigation, corn did not respond any differently to ammonium polyphosphate than it did to monoammonium phosphate. The only noticeable response to fertilizer placement occurred in 1968 when soil temperatures were colder. Under more favorable growing conditions in 1969, no response occurred.

The results of this test indicated that row fertilizer, particularly phosphorus, is important for getting corn off to a quick start, particularly during cool wet growing seasons. Starter fertilizer is helpful even on medium to high fertility soils. The early growth response was the same regardless of whether the row fertilizer was applied in a band approximately 2 inches to the side and 2 inches below the seed or in direct contact with the seed (pop-up). No yield response was obtained as a result of the placement treatments.

The only advantage observed for "pop-up" fertilization was that it provides a means for minimizing the amount of fertilizer normally handled by the farmer at planting time. The use of pop-up fertilizer would reduce time lost filling fertilizer boxes on the planter, thus enabling the farmer to plant more of his acreage at the most favorable time.

Table 1. Fertilizer treatments.

Tmt. No.	P.D.[1]	Band	Pop-up	S.D.[2]	P Source[3]
1	70-115-125	----	----	75-0-0	MAP
2	70-0-125	----	----	75-0-0	MAP
3	70-0-125	----	3-12-3	75-0-0	MAP
4	55-55-110	15-60-15	----	75-0-0	MAP
5	70-115-125	----	3-12-3	75-0-0	MAP
6	55-55-110	15-60-15	3-12-3	75-0-0	MAP
7	70-115-125	----	----	75-0-0	APP
8	70-0-125	----	----	75-0-0	APP
9	70-0-125	----	3-12-3	75-0-0	APP
10	55-55-110	15-60-15	----	75-0-0	APP
11	70-115-125	----	3-12-3	75-0-0	APP
12	55-55-110	15-60-15	3-12-3	75-0-0	APP

[1]Plow down. [2]Sidedress. [3]MAP - monoammonium phosphate, APP - ammonium polyphosphate.

Table 2. The effect of phosphorus source and fertilizer placement on plant height (6/16/69).

Phosphorus Source[1]	Treatment Number						Average
	1 & 7	2 & 8	3 & 9	4 & 10	5 & 11	6 & 12	
	Inches						
MAP	33	30	34	34	36	37	34
APP	34	31	34	37	34	38	35
Ave.	34	30	34	35	35	37	

[1]See Table 1 for explanation of treatments.

Table 3. The effect of phosphorus source and fertilizer placement on nitrogen content of whole corn plants and corn ear leaf samples.

Phosphorus Source*	Treatment Number 1 & 7	2 & 8	3 & 9	4 & 10	5 & 11	6 & 12	Average
			% N (Whole Plant)				
MAP	3.2	3.1	2.9	3.1	3.1	3.2	3.1
APP	3.4	3.5	2.9	3.0	3.0	3.1	3.1
Ave.	3.3	3.3	2.9	3.0	3.0	3.1	
			% N (Ear Leaf)				
MAP	2.7	2.7	2.8	2.8	2.8	2.7	2.8
APP	2.8	2.8	2.4	2.7	2.6	2.5	2.6
Ave.	2.8	2.7	2.6	2.8	2.7	2.6	

*See Table 1 for explanation of treatments.

Table 4. The effect of phosphorus source and fertilizer placement on potassium content of whole corn plants and corn ear leaf samples.

Phosphorus Source*	Treatment Number 1 & 7	2 & 8	3 & 9	4 & 10	5 & 11	6 & 12	Average
			% K (Whole Plant)				
MAP	4.3	4.0	4.2	4.2	4.2	4.2	4.2
APP	4.2	4.0	4.1	4.2	4.0	4.3	4.1
Ave.	4.3	4.0	4.2	4.2	4.2	4.2	
			% K (Ear Leaf)				
MAP	2.2	2.2	2.0	2.2	2.2	2.2	2.2
APP	2.0	2.0	2.2	2.2	2.2	2.0	2.1
Ave.	2.1	2.1	2.1	2.2	2.2	2.1	

*See Table 1 for explanation of treatments.

Table 5. The effect of phosphorus source and fertilizer placement on calcium content of whole corn plants and ear leaf samples.

Phosphorus Source*	Treatment Number 1 & 7	2 & 8	3 & 9	4 & 10	5 & 11	6 & 12	Average
			% Ca (Whole Plant)				
MAP	.43	.42	.43	.43	.48	.44	.44
APP	.43	.40	.44	.45	.42	.43	.43
Ave.	.43	.41	.44	.44	.45	.44	
			% Ca (Ear Leaf)				
MAP	.62	.69	.74	.65	.62	.67	.66
APP	.72	.70	.67	.70	.70	.70	.70
Ave.	.67	.69	.70	.68	.66	.69	

*See Table 1 for explanation of treatments.

Table 6. The effect of phosphorus source and fertilizer placement on magnesium content of whole corn plants and ear leaf samples.

Phosphorus Source*	Treatment Number 1 & 7	2 & 8	3 & 9	4 & 10	5 & 11	6 & 12	Average
			% Mg (Whole Plant)				
MAP	.29	.31	.27	.30	.28	.28	.29
APP	.30	.30	.31	.32	.29	.27	.30
Ave.	.29	.30	.29	.31	.29	.28	
			% Ca (Ear Leaf)				
MAP	.20	.23	.24	.22	.21	.23	.22
APP	.23	.24	.24	.21	.22	.21	.22
Ave.	.22	.24	.24	.22	.22	.22	

*See Table 1 for explanation of treatments.

Table 7. The effect of phosphorus source and fertilizer placement on phosphorus content of whole corn plants and ear leaf samples.

Phosphorus Source*	Treatment Number 1 & 7	2 & 8	3 & 9	4 & 10	5 & 11	6 & 12	Average
			% P (Whole Plant)				
MAP	.33	.33	.28	.34	.29	.30	.31
APP	.33	.32	.29	.34	.31	.33	.32
Ave.	.33	.32	.28	.34	.30	.31	
			% P (Ear Leaf)				
MAP	.34	.34	.33	.36	.36	.37	.35
APP	.36	.33	.34	.36	.34	.34	.34
Ave.	.35	.33	.34	.36	.35	.36	

*See Table 1 for explanation of treatments.

Table 8. The effect of phosphorus source and fertilizer placement on corn grain yields (15.5% H_2O).

Phosphorus Source*	Treatment Number 1 & 7	2 & 8	3 & 9	4 & 10	5 & 11	6 & 12	Average
			Bu/A				
MAP	143.8	142.7	154.0	142.4	135.2	153.1	145.2
APP	149.7	159.5	151.6	158.2	145.5	148.0	147.9
Ave.	146.8	151.1	152.8	150.3	140.4	150.6	

*See Table 1 for explanation of treatments.

Table 9. The three year average of the effect of phosphorus source and fertilizer placement on corn grain yields (15.5% H_2O).

Phosphorus Source*	Treatment Number 1 & 7	2 & 8	3 & 9	4 & 10	5 & 11	6 & 12	Average
			Bu/A				
MAP	125.3	121.1	125.4	125.7	115.1	126.0	123.1
APP	128.7	132.3	127.8	126.2	121.6	124.9	125.5
Ave.	127.0	126.7	126.6	125.9	118.4	125.5	

*See Table 1 for explanation of treatments.

Influence of Insecticides and Nematocides on Soybean Yield, N Fixation, and Serological Distribution of *Rhizobium Japonicum*

D. F. Bezdicek and J. A. Schillinger
Department of Agronomy

Purpose and Objectives

Several nematocides and systemic insecticides have been tried in previous years to control the Mexican bean leaf beetle and root knot nematode. Several of these compounds have given soybean yield increases where nematodes and insects were not considered a problem. The growth stimulating effects of these compounds were, therefore, questioned. The influences of these compounds on N fixation and Rhizobium strain were considered. The following objectives were initiated in studying the influence of several insecticides and nematocides on soybeans in regard to: (1) Nitrogen fixation by soybean nodules and (2) the serological distribution of *Rhizobium japonicum* serogroups within soybean nodules.

Procedures

Two soils were used in this investigation: Matapex silt loam at the Wye Institute, Centerville, and Fallsington sandy loam near Pocomoke in Worcester County. The following treatments were used at the Wye site.

Plot Size: 10 x 20' - 4 row plots

Treatments:
- Thimet-1 #/A in 8" band
- Thimet-zinophos-1 #/A in 8" band
- Temik-3 #/A in 8" band
- Furidan-1 #/A as 8" band
- Telone-1 #/A injected near row
- Fumazone-1 #/A injected near row
- Control - no inoculum
- Control - strain 110 + 125

Varieties: Kent and Delmar

A completely random design was used with four replications.

Plot characteristics for the Pocomoke site are as follows:

Plot size: 3 row plots 20 x 7.5'

Treatments: Thimet-1 #/A as 8" band

Thimet-zinophos-1 #/A as 8" band

Temik-3 #/A as 8" band

Telone-1 #/A injected near row

Fumazone-1 #/A injected near row

Control - no inoculum

Varieties: Cutler and York

Soybeans were planted with insecticide and nematocide applications on April 22 and 23. Nitrogen fixation was measured at mid-bloom by slight modification of the acetylene-ethylene method of Hardy et al[1]. Nodules were sampled at the same time and serologically typed across Beltsville serological groups.

Results

Results for the Wye study in Table 1 show that the treatments had very little influence on soybean yield, N fixation or nodule number. Considerable variation in N fixation rate was present from plant to plant. Nodule numbers and fixation rate were slightly higher for the Kent variety.

Treatment effects were not consistent at the Pocomoke location as shown in Table 2. Considerable variation in N fixation was also observed at this site although total nodule numbers and N fixation rate were much higher than found at the Wye location.

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[1] Hardy, R. W. F., R. D. Holsten, E. K. Jackson, and R. C. Burns. 1968. Plant Physiology 43: 1185-1207.

Serological distribution of nodules sampled from the Pocomoke site are shown in Table 3. The application of insecticides and nematocides apparently has little influence on serological distribution since consistent trends were not found.

Summary

Application of several insecticides and nematocides to soybeans at two locations resulted in very little change in yield, N fixation rate and nodule numbers.

Table 1. Soybean yield, N fixation rate and nodule properties as influenced by insecticide and nematocide additions at the Wye location.

Treatment	Application Rate Lb/A	Yield[1] Bu/A	N Fixation[2] µl ethylene/ hr/plant	Nodule No/plant[2]
		Variety - Delmar		
Thimet	1	49.5	2.8	16.4
Thimet-Zinophos	1	51.1	4.6	14.7
Temik	3	48.6	10.2	18.8
Furidan	1	48.0	7.5	25.0
Telone	1	42.9	10.0	11.7
Fumazone	1	52.6	10.2	16.6
Control	-	49.4	--	--
Control (inoculated)	-	50.6	3.3	13.8
		Variety - Kent		
Thimet	1	52.2	11.6	23.1
Thimet-Zinophos	1	48.6	11.3	30.1
Temik	3	49.8	5.1	24.2
Furidan	1	46.0	10.1	19.1
Telone	1	50.1	22.2	28.4
Fumazone	1	49.0	23.4	26.4
Control	-	54.9	--	--
Control (inoculated)	-	50.8	7.7	15.4

[1] Average of 4 replications.

[2] Average of 3 determinations per replication.

Table 2. Soybean yield, N fixation rate, and nodule properties as influenced by insecticide and nematocide additions at the Pocomoke location.

Treatment	Application Rate Lb/A	Yield[1] Bu/A	N Fixation[2] µl ethylene/ plant/hr	Nodule No's[2] Nod's/plant	Nod wt[2] g/plant
		Variety - Cutler			
Thimet	1	46.9	57	99	1.8
Thimet-Zinophos	1	50.1	42	81	1.2
Temik	3	46.1	23	70	1.0
Fumazone	1	48.5	15	76	1.3
Telone	1	46.6	42	81	1.2
Control	-	46.9	22	77	1.2
$\bar{X}$		47.5			
		Variety - York			
Thimet	1	52.5	31	100	1.8
Thimet-Zinophos	1	44.3	26	100	1.7
Temik	3	52.4	68	77	1.4
Fumazone	1	47.5	54	97	1.9
Telone	1	48.8	12	88	1.3
Control	-	46.3	50	82	1.2
$\bar{X}$		48.6			

[1] Average of 3 replications: $LSD_{.05}$ = 4.2 Bu/A.

[2] Average of 3 determinations per replication.

Table 3. Distribution of Rhizobium japonicum serogroups as influenced by insecticide and nematocide application at the Pocomoke location.

Treatment	Serogroup* %						
	122	76 & 76-125-135	38	6	C_2	125	Other
Variety - Cutler							
Thimet	32.0	6.9	11.5	1.7	3.4	11.1	33.1
Thimet-Zinophos	30.1	8.2	7.2	5.4	2.7	22.9	21.0
Temik	34.7	7.6	7.3	2.6	0.9	11.9	34.8
Fumazone	26.9	10.9	9.5	0.8	4.2	17.6	29.7
Telone	26.4	6.2	8.7	3.5	1.0	16.7	37.6
Control	32.7	6.8	10.2	1.7	4.2	11.8	31.8
Variety - York							
Thimet	19.1	10.1	3.5	3.8	5.2	12.2	13.1
Thimet-Zinophos	27.0	10.0	8.4	5.1	7.5	19.3	22.7
Temik	28.8	15.9	4.3	2.5	7.6	14.6	27.1
Fumazone	20.8	17.5	5.0	6.7	2.5	18.3	29.2
Telone	17.6	5.0	6.8	5.1	16.0	16.7	30.3
Control	30.3	8.8	6.2	7.2	4.6	8.7	32.4

*Beltsville serogroups: Average of 3 replications with 40 nodules per replication.

Movement of Nitrate in Soil

D. F. Bezdicek
Department of Agronomy

Purpose and Objectives

Current emphases on the environment has prompted researchers to look more closely at fertilization practices relating to nitrates in ground water. The literature contains conflicting information on the extent of ground water nitrates from fertilizers. This is partially due to the absence of a suitable nitrogen tracer that can be used in fertilizers. The isotope, ^{15}N is available, however, the cost of label and analysis prohibits its use on an agronomic scale. With studies of unlabeled fertilizer application at agronomic rates, it is often difficult to account for the fertilizer N since the amount added to the soil is too small for detection. Consequently, larger quantities of fertilizer were added in this study in order to better account for the added N. The objectives were (1) to study the distribution of nitrate in the soil profile as influenced by high fertilization rates, and (2) estimate total N recovery from total soil N and crop removal.

Procedures

The two locations selected for this study were at the Wye Institute near Centerville and the Tobacco Farm near Upper Marlboro, Maryland. These sites represent silt loam and sandy soils, respectively. The Wye Institute site was initiated in 1969 whereas the site at the Tobacco Farm will be initiated in spring, 1970.

A completely randomized 3 x 4 factorial design was used with the following characteristics:

Plot size: 20 x 25'

N fertilizer: NH_4NO_3 at 0, 250, 500 and 1000 lbs. N/A applied annually

Crops: corn, fescue and fallow

Replications: 4

Red fescue was established in the spring of 1969 at the Wye location. An established sod is present at the Tobacco Farm. DeKalb XL66 was planted at the Wye in 1969. Forage samples were taken in mid-September whereas grain yield was taken in late September. Soil cores were sampled at one foot intervals to five feet in mid September. Twenty five grams of air-dried sample were added to 75 ml water and shaken for $\frac{1}{2}$ hour and filtered. Nitrate concentration was determined on a Beckman pH meter equipped with an Orion nitrate electrode.

Results

Nitrate levels in the soil profile as influenced by cultural practice and N fertilization are shown in Table 1. Nitrate levels generally increased with increased rates of fertilization at all sampling depths. With rates to 500 lbs. N/A, nitrate levels at the deeper depths were lower for corn than that with either fallow or fescue. Nitrate appeared deeper in the profile for fallow than for corn or fescue. Apparently roots from these crops reduced the movement of nitrate downward. Furthermore, the fallow plot contained more soil moisture which may account for the higher nitrate levels in the lower profile. Corn plots appeared to contain more nitrate at the zero to 12-inch depth than for either fallow or fescue.

Summary

Nitrate movement through the profile generally did not occur beyond the 24-inch depth six months after fertilizer application for the corn and fescue treatments. However, more nitrate was present beyond 24-inches for the fallow treatment. As much as 170 ppm NO_3-N was found within the 12-inch depth for corn at the 1000 lb. N treatment. Subsequent soil sampling this year should reveal more conclusively the extent of nitrate movement under these experimental conditions.

Table 1. Nitrate levels in soil profile as influenced by cultural practices and rate of fertilization at the Wye location.

Fertilizer lbs./A, NH_4NO_3-N	Depth inches	ppm N as NO_3- in soil*		
		Corn	Fallow	Fescue
0	0-12	8	6	8
	12-24	1	2	7
	24-36	1	3	2
	36-48	1	3	2
	48-60	1	2	1
250	0-12	40	32	23
	12-24	15	9	18
	24-36	4	5	5
	36-48	1	6	4
	48-60	1	6	3
500	0-12	51	29	31
	12-24	19	18	12
	24-36	3	16	5
	36-48	2	8	3
	48-60	1	5	3
1000	0-12	170	104	99
	12-24	35	34	37
	24-36	4	15	7
	36-48	5	11	5
	48-60	3	8	3

*Expressed on oven-dried basis.

Correlation of *Rhizobium japonicum* Serogroups With Soil Parameters in Two Maryland Soils

D. F. Bezdicek
Department of Agronomy

Purpose and Objectives

Rhizobium japonicum bacteria infect soybeans and produce nodules. Many strains of this species existing in the soil have different morphological and physiological properties that manifest themselves in agronomic traits such as differences in nodulation, N fixation and plant growth. Fortunately, many of these strains can be typed into serological groups enabling one to study these strains by serologically typing the nodules. The proportion of certain serological groups on a single soybean plant are determined by a variety of soil ecological variables, plant variety and previous inoculation practices. The objectives of this investigation were to study (1) the serological distribution of *R. japonicum* in two main soil types in Maryland, and (2) the correlation of these serogroups with numerous soil test variables.

Procedures

Twenty-one soybean fields were selected throughout Dorchester and Somerset Counties from two soil types: Sassafras sandy loam and Matapeake silt loam. Soil samples for analysis of pH, P, K, Ca, Mg, Mn, organic matter, and organic N were taken at planting and immediately before harvest. Nodules (45/location) were pooled from five plants and analyzed serologically for somatic agglutination with Beltsville antisera. Soybean yields were obtained and placed in a correlation matrix with the other variables.

Results

The distribution of serogroups for the two soils studied is shown in Table 1. Considerable variation of serogroups existed within each soil type although no single group predominated in either soil. The data indicate that

a wide variety of serogroups were present. This is contrary to data from the midwest which suggests that serogroup 123 often predominates. The relatively large proportion of serogroups not accounted for with the Matapeake soil may be due to larger proportion of decayed nodules sampled.

The relationship of serological groups with soil tests is shown in Table 2. The positive correlation of serogroup 110 with soil organic matter, organic N, NH_4^+ and NO_3^- indicates that this group can tolerate the higher N status. This characteristic is important since strains within 110 are highly efficient in N fixation. Conversely, serogroups 125 and 123 were negatively correlated with organic N. Serogroup 123 appears to favor a higher pH environment since positive correlations were obtained with soil pH and soil Mg. Data from Iowa suggest the opposite effect of soil pH on serogroup 123. However, Iowa data further indicate that many different strains exist within the 123 serogroup.

Correlation data for the Matapeake soil in Table 2 suggest a different pattern. Soil N is no longer related to serogroup 110, however, organic N is positively correlated with serogroups 122 and 94. The negative correlation of organic N with serogroup 123 is consistent with the results obtained for the Sassafras soil. Since the N content of the Sassafras soil is lower than that for Matapeake, N may be an important ecological factor for serogroup 110 under lower N levels. Serogroup 76 was negatively correlated with soil P whereas in the Sassafras soil, soil K was positively correlated.

Summary

Distribution of R. japonicum in soybeans was found to vary little between Sassafras sandy loam and Matapeake silt loam although considerable variation existed within the two soils. Serogroup 110 was highly correlated with soil organic and inorganic N for the Sassafras soil but not for the Matapeake. Serogroup 123 was negatively correlated with organic N for both soils. It is apparent that certain soil ecological conditions exist that determine the distribution of R. japonicum in the soil as evidenced by serological typing.

Table 1. Percent distribution of Rhizobium japonicum serological groups* for nodules taken from two soil types.

Serogroup (%)							
125	110	122	94	76	46	123	Other
			Sassafras Sandy Loam				
6.7	11.1	28.9	15.5	6.7	13.3	0	17.8
4.4	2.2	22.2	6.7	31.1	17.7	6.7	9.0
2.2	4.4	4.4	17.8	28.9	15.5	13.3	13.5
6.7	20.0	15.5	8.9	8.9	13.3	0	26.7
0	11.1	8.9	8.9	17.8	11.1	6.7	38.5
0	11.1	22.2	4.4	8.9	8.9	0	44.5
4.4	0	35.5	4.4	11.1	15.5	0	29.1
17.7	0	6.7	13.3	17.8	20.0	24.4	0
0	6.7	30.1	2.2	2.2	8.9	35.5	14.4
4.4	8.8	11.1	17.8	6.6	22.2	6.6	22.5
Ave. 4.7	7.5	18.6	10.0	14.0	14.6	9.3	21.3
			Matapeake Silt Loam				
6.7	13.3	11.2	13.3	6.2	8.9	2.2	37.7
13.3	13.3	11.1	0	0	4.4	28.9	19.0
0	6.7	17.8	4.4	6.7	6.7	15.5	42.2
6.7	2.2	8.9	2.2	13.3	13.3	0	53.4
8.9	8.9	4.4	35.5	4.4	2.2	0	35.7
4.4	6.7	15.5	8.9	4.4	2.2	6.7	51.2
2.2	0	8.9	0	4.4	11.1	24.4	49.1
6.7	4.4	24.4	2.2	11.1	15.5	11.1	24.6
6.7	8.9	13.3	11.1	13.3	24.4	15.5	6.8
Ave. 6.2	7.2	12.8	8.6	6.5	9.9	11.6	35.5

*Beltsville Serological Groups - 45 nodules/observation.

The author is indebted to Dr. D. Weber and V. Miller, Soybean Investigations, USDA, Beltsville, Maryland for providing the serological material and information. Appreciation is expressed to R. L. Johnson and L. R. Wade, County Extension Agents, for their assistance in locating sites.

Table 2. Correlations obtained between Beltsville serological groups (*Rhizobium japonicum*) and various soil analyses for Sassafras sandy loam and Matapeake silt loam.

Serogroup	Soil Parameters[1]	
	Positive	Negative
	Sassafras Sandy Loam	
125		Organic N
110	OM, organic N NH_4^+, NO_3^-	
122		
94		
76	Soil K	
46		
123	pH, Soil Mg	Organic N
Other groups	Organic N	Yield, Soil Mg
	Matapeake Silt Loam	
125		
122	Organic N	
94	Organic N, NH_4^+	
76		Soil P
46		
123		Organic N
Other groups	Organic N, OM	

[1] Correlations of 5% significance or greater.

Response of Corn to Applied Zinc and a Comparison of Three Chemical Extractants for Determining Available Zinc

C. B. Coffman and J. R. Miller
Department of Agronomy

Purpose and Objectives

Zinc deficiency is not a widespread problem in Maryland at the present time. The deficiency has been found primarily in corn grown in the Coastal Plain section. However, as cropping becomes more intensive and growers aim for higher yields, it is anticipated that zinc deficiency will become a more serious problem in Maryland.

A number of soil tests have been used for determining available zinc. In most cases more correlation and calibration data are needed for the methods to be more useful in diagnosing zinc problems. Thus a greenhouse experiment was established to determine the response of corn to applied zinc on 12 important Maryland soils. In addition, three soil test methods were compared to determine the feasibility of using these methods for measuring available zinc in soils.

Procedures

The response of corn to applied zinc on 12 Maryland soils was investigated in the greenhouse. The chemical characteristics of these soils are given in Table 1. Zinc was applied to the soils at the rate of 0, 1.5, 2.5, 5, 10, 20 and 40 ppm as zinc sulfate. All treatments were replicated three times. The soils were limed to pH 6.5 and received 150 ppm of potassium (K). Corn yields were obtained 30 days after emergence and the plant tissue was analyzed for zinc.

Soil samples were obtained prior to growing the corn and were analyzed for zinc at each level of zinc application. The extractants used were 0.05N HCl plus 0.025N H_2SO_4, 0.1N HCl, and 0.01M EDTA plus 1.0M $(NH_4)_2CO_3$.

Results

The dry matter yield of corn grown on 11 of the 12 soils used in this investigation did not increase significantly with the application of 1.25 to 40 ppm of zinc (Table 2). However, an application of 1.25 ppm zinc on the Othello silt loam soil from Somerset County resulted in almost a 100 percent increase in yield. This rate of zinc prevented the development of zinc deficiency symptoms which were noted in the plants when no zinc was applied. As the level of applied zinc was increased above 1.25 ppm there was no further significant increase in yield. The Othello soil which gave the zinc deficiency has a pH of 6.6 plus a high level of phosphorus. In most cases zinc deficiency is associated with cold-wet soils, high pH and high phosphorus levels.

The dry matter yield of corn grown on the Chester silt loam decreased as the level of applied zinc increased (Table 2). There were no apparent symptoms of toxicity in the corn except for stunted plant growth.

The zinc content of the corn receiving several levels of applied zinc is given in Table 3. The zinc content of the corn receiving no zinc ranged from 10.2 ppm for the Othello soil from Somerset County to a high of 26.6 ppm for the Hagerstown soil from Washington County. It can be noted when zinc was applied at 40 ppm on the different soils the corn contained as much as 184 ppm of zinc. Under the conditions of this experiment the level of zinc in corn above which no further significant increase in yield resulted was found to be about 12 ppm. However, since only one soil in the investigation showed an increase in yield with an application of zinc, additional research is needed to determine more precisely the critical level for zinc in corn.

The zinc extracted by the 0.05N HCl and 0.025N H_2SO_4 from the 12 soils receiving no zinc ranged from a low of 0.3 ppm in the zinc deficient Othello

soil to a high of 1.5 ppm in the Matapeake and Chester soils. It appears that with the HCl-H_2SO_4 extractant, 0.5 ppm would be adequate for corn.

The zinc extracted from the 12 soils by each of the three chemical methods was correlated with the zinc content of the above ground portion of the corn plants. The correlation coefficient for the 0.05N HCl plus 0.025N H_2SO_4 extractant was 0.834; for the 0.1N HCl extractant it was 0.854; and for the 0.01M EDTA plus 1.0M $(NH_4)_2CO_3$ extractant it was 0.787. The correlation coefficients (r values) for all three methods were statistically significant at the 1 percent level. The two acid extracting solutions were found to be the most practical for determining available zinc. The 0.05N HCl plus 0.025N H_2SO_4 appeared to be slightly better than the 0.01N HCl for routine analyses because of its shorter laboratory procedure. The 0.01M EDTA plus 1.0M $(NH_4)_2CO_3$ was very difficult to work with due to salt precipitation within the aspirator of the atomic absorption spectrophotometer.

Summary

Considerable research has been conducted in the greenhouse and field on zinc. At the present time zinc deficiency is not widespread in Maryland. The deficiency is primarily found in corn grown on the Eastern Shore and is associated with cold-wet soils, a soil pH above 6.5 and high soil phosphorus levels.

In this investigation the approximate level of zinc in the corn tissue above which there was no further significant increase in the yield was 12 ppm. It appears that with the 0.05N HCl plus 0.025N H_2SO_4 extractant, 0.5 ppm of zinc in the soil would be adequate for corn.

Table 1. The chemical characteristics of the Ap horizons of twelve Maryland soils.

Soil Type	County	pH	Organic Matter %	Total CEC	Ca	Mg	K	P
				me./100g				ppm
Calvin silt loam	Garrett	6.3	1.42	9.5	5.4	0.2	0.2	17
Chester silt loam	Montgomery	6.2	1.21	8.2	5.3	0.5	0.1	14
Collington loamy sand	Prince George's	5.6	0.40	4.4	1.5	0.3	0.3	92
Downer loamy sand	Somerset	6.3	0.56	3.4	2.5	0.4	0.2	143
Elkton silt loam	Dorchester	5.0	1.51	9.2	2.6	1.4	0.2	17
Hagerstown silt loam	Washington	6.9	1.44	9.3	9.2	0.7	0.3	14
Matapeake silt loam	Cecil	6.7	1.09	6.3	3.8	0.8	0.2	23
Matapeake silt loam	Queen Anne's	5.2	0.64	4.3	2.7	0.3	0.1	16
Myersville silt loam	Frederick	7.1	1.32	16.4	16.2	3.9	0.2	9
Othello silt loam	Somerset	6.6	3.55	9.8	5.3	2.3	0.2	57
Othello silt loam	Talbot	6.2	0.92	7.4	6.4	0.7	0.1	37
Sassafras sandy loam	Talbot	7.1	0.74	3.7	3.6	1.4	0.1	16

Source: Wright, W. R. 1969. Contributions of clay and organic matter to the cation exchange capacity of Maryland soils. M.S. thesis. Copy on file, University of Maryland Library, College Park, Maryland. The available phosphorus was determined by method outlined in University of Maryland Agronomy Mimeo No. 37 and is not reported in thesis.

Table 2. The effect of several rates of applied Zn on the yield of corn grown on 12 Maryland soils.

Soil Series	County	Dry Matter Yield g/pot						
		Zn Applied - ppm						
		0	1.25	2.5	5	10	20	40
Calvin	Garrett	16.1a*	17.5a	18.4a	16.4a	18.8a	17.0a	18.3a
Chester	Montgomery	21.1a	13.2b	11.0b	13.0b	14.8b	11.8b	9.6b
Collington	Prince George's	25.4a	25.2a	23.1a	25.5a	24.7a	24.5a	23.3a
Downer	Somerset	21.4a	25.1a	23.5a	23.4a	26.8a	26.3a	25.9a
Elkton	Dorchester	20.9a	18.4a	18.4a	21.7a	22.4a	18.7a	19.1a
Hagerstown	Washington	20.0a	14.7b	17.3a	18.5a	19.4a	21.7a	17.5a
Matapeake	Cecil	14.1a	16.7a	18.6a	16.4a	17.3a	18.3a	18.4a
Matapeake	Queen Anne's	18.6a	15.9a	18.4a	20.0a	20.2a	19.2a	19.2a
Myersville	Frederick	21.6a	17.2a	18.8a	17.9a	19.4a	18.7a	18.5a
Othello	Somerset	7.2a	14.0b	18.8b	18.9b	16.2b	17.4b	19.1b
Othello	Talbot	25.2a	24.2a	25.9a	28.9a	23.6a	25.7a	28.6a
Sassafras	Talbot	22.9a	23.4a	24.0a	21.8a	23.1a	23.7a	24.7a

*Any two means (within a soil) not followed by the same letter, are significantly different at the 5 percent level.

Table 3. The effect of several rates of applied Zn on the Zn content of corn grown on 12 Maryland soils.

Soil Series	County	Zn Content - ppm							
		Zn Applied - ppm							
		0	1.25	2.5	5	10	20	40	Mean
Calvin	Garrett	16.4d*	23.1d	45.3bcd	35.1d	66.2bc	95.0b	151.8a	61.8
Chester	Montgomery	16.4c	43.5bc	34.6bc	57.3b	52.4b	94.1a	118.1a	59.5
Collington	Prince George's	24.0d	29.9d	30.2d	43.9cd	63.0c	102.1b	184.0a	68.2
Downer	Somerset	16.0c	20.4c	17.8c	20.2c	30.0c	82.1b	119.9a	43.8
Elkton	Dorchester	24.0c	34.6c	28.4c	37.5c	52.4bc	83.0b	156.7a	59.5
Hagerstown	Washington	26.6e	32.9de	32.9de	41.7de	59.1cd	79.0bc	128.8a	57.3
Matapeake	Cecil	13.3e	28.4de	37.3cde	50.6cd	66.8bc	100.8ab	107.9a	57.9
Matapeake	Queen Anne's	12.0e	26.6de	38.2de	43.5cd	73.7e	127.9b	176.3a	71.2
Myersville	Frederick	25.3b	21.3b	28.4b	34.6b	49.7ab	42.6ab	72.4a	39.3
Othello	Somerset	10.2c	26.6bc	20.9bc	38.2bc	48.8b	93.2a	119.8a	51.1
Othello	Talbot	21.8c	25.7c	24.0c	40.8c	45.3bc	79.9a	86.3a	46.2
Sassafras	Talbot	19.1d	21.8d	22.2d	33.4d	66.2e	104.8b	174.5a	63.1
Mean		19.8	27.9	30.0	39.7	61.3	90.4	133.0	

*Any two means (within a soil) which are not followed by the same letter are significantly different at the 5 percent level.

Cation Exchange Capacity Studies

D. S. Fanning and R. F. Korcak
Department of Agronomy

Purpose and Objectives

It is well known that the cation exchange capacity of a soil depends upon how it is determined. Cations react differently with certain minerals. For example, potassium and ammonium are fixed (retained non-exchangeable) by vermiculite, whereas calcium and magnesium are not. Also the CEC varies with pH, and the amount of this variation is dependent upon kind and quantity of organic matter and the mineralogy of the soil. Free iron oxides may also interact with clay minerals so as to affect their cation exchange capacity. The purpose of a newly initiated project is to study the exchange capacity of some of the major soils of Maryland as determined by different methods and to use this information to develop an improved model of the exchange complex of these soils. These studies should eventually show the amount of vermiculite in these soils, the amount of pH dependent CEC between pH 5 and 7 (values critical in the liming of Maryland soils) and the influence of iron oxides on the CEC of these soils.

The specific objectives of the studies that are reported here were:

1. To determine the difference between CaEC (calcium exchange capacity) and KEC (potassium exchange capacity) for B horizon samples from Myersville soils that according to earlier clay mineral studies have high contents of vermiculite.
2. To determine the CaEC with saturation by $CaCl_2$ vs. Ca acetate for B horizon samples from Sassafras and Pocomoke soils (Coastal Plain soils that are suspected of having considerable pH dependent charge).
3. To study the effect of removing free iron oxides and organic matter on the exchange capacity values determined.

Procedures

Soils were saturated with either Ca or K cations by centrifuge washing 0.5g soil samples once with a 1N solution of the salt and 5 times with a 0.1N solution. After pouring off the last 0.1N washing, the amount of excess solution left in the centrifuge tube was determined by weighing, the weight of the tube and the soil having been previously determined. The exchangeable cations and excess salt were then replaced by centrifuge washing the sample with five 10 ml portions of 1N salt solutions (NH_4 was used to replace K and Mg to replace Ca). The replacement solution was made to a 100 ml volume and the concentration of the element (K or Ca) in this solution was measured by flame photometry on the Technicon Auto-Analyzer by the Soil Testing Laboratory. The CEC values were calculated from these data after correcting for the amount of excess salt (known from the weight and concentration of the excess solution left in contact with the soil prior to replacement).

Hydrogen peroxide was used in a 1N pH 5 Na acetate system to remove organic matter, and free iron was removed by the sodium citrate-bicarbonate-dithionite method for those samples from which these constituents were removed.

Results

Some characteristics of the samples that were studied as determined by W. R. Wright for his M.S. thesis, are given in Table 1. All samples were from B horizons and contained low amounts of clay (by the pipette method) and organic matter. The Pocomoke sample contained somewhat less clay and more organic matter than the other samples. The exchange capacity of the Myersville samples was much higher than for the Pocomoke and Sassafras and the difference between the CEC by sum of cations as opposed to CEC by pH 7

NH_4OAc was also much greater for the Myersville soils. Since vermiculite fixes ammonium, this was thought to be related to the vermiculitic mineralogy of the Myersville soil as indicated by x-ray diffraction.

The new data for the Myersville soils (Table 2) show that CaEC values as determined by pH 7.4 $Ca(OAC)_2$ saturation and $Mg(OAC)_2$ replacement were even higher than CEC by sum of cations for these samples. The lower values by sum of cations may be caused by blocking off of exchange sites by NH_4 which is used for replacement in the sum of cations method. This may prevent some cations, which would otherwise be replaced and thus counted as exchangeable cations, from being released for measurement by the sum of cations method.

The KEC values (Table 2) were even lower than the values by the pH 7 NH_4AOC method (Table 1). The greater fixation of K was probably caused by the overnight drying and heating at 110C prior to replacement during the KEC determination. The big difference between the CaEC and KEC values (Table 2) is considered to be caused by K fixation when the samples were K saturated, since both of the saturating solutions ($Ca(OAC)_2$ and KOAc) were at the same pH. The difference between CaEC and KEC is an index of the amount of vermiculite present in the samples. By assuming that vermiculite has an exchange capacity of 154 me/100 g, and that all of this is blocked by K, then the percent of vermiculite (Vr) in the samples could be calculated (Table 2). It is interesting to note that when this was done, the amount of vermiculite in the samples was greater than the clay content of the samples (Table 1). This lends more support to the idea that much of the exchange material of these soils is in the silt and sand fractions. In such soils an estimate of the amount of reactive minerals, such as vermiculite, on a whole soil basis is much more meaningful from a practical point of view than studies on a separated clay fraction.

Removing organic matter had very little effect on the exchange capacity values of the Myersville soils (Table 2). Removing iron oxides tended to increase the values a small amount; however, it did not change the difference between CaEC and KEC enough to significantly affect the calculated vermiculite content.

Further studies are underway to check the amount of K fixation when the samples are not dried or are only air dried at room temperature (as opposed to 110C dried) between K saturation and replacement.

Studies of the Sassafras and Pocomoke B horizon samples (Table 3) agreed with the earlier results (Table 1) in showing that these materials have much lower CEC values than the Myersville soils. Calcium saturation using $Ca(OAc)_2$ gave CaEC values that were normally about twice as great as when saturation was with $CaCl_2$ (Table 2). This difference is considered to be attributable to much more opening up of the pH dependent charge sites by the $Ca(OAc)_2$, which had a pH of 7.4. The $CaCl_2$ solutions had a pH of about 6.3 and were not buffered. Thus the samples saturated with $CaCl_2$ presumably maintained their native pH of about 5 (Table 1) during saturation.

The H_2O_2 treatment for removing organic matter tended to lower the CEC values somewhat for the Pocomoke soil, but in some cases actually increased the values for the Sassafras soil. Removing free iron generally increased the values. However, this increase may be caused by some side effect of the free iron removal treatment since the Pocomoke contained no free iron (Table 1), but still showed a slight increase with the free iron removal treatment if the H_2O_2 treatment had been given. This side effect could be an opening of pH dependent exchange sites by the free iron removal treatment since it is buffered at pH 7.4. A reversal of the trend, a decrease in CEC with free iron removal, was obtained with the Pocomoke when the H_2O_2 treatment was not

given and saturation was with $Ca(OAc)_2$. This may have been caused by organic matter removal during the free iron removal treatment. The free iron extract was yellow, even though no free iron was extracted. This yellow color probably was from dissolved organic matter. Since the CEC of organic matter is quite pH dependent, its removal apparently caused a decrease in CEC with the $Ca(OAc)_2$ saturation.

Further studies of the pH dependent CEC of these soils will be made by comparing the CaEC as determined by $Ca(OAc)_2$ saturation with buffering at pH values of 5 and 7. Many Coastal Plain soils by x-ray studies appear to have an exchange complex like that of the Sassafras and Pocomoke materials and thus the results of these studies should apply to soils throughout much of the Coastal Plain. Studies need to be extended to other horizons, however.

Summary

Cation exchange studies were conducted on B horizon samples from the Myersville, Sassafras and Pocomoke soils. The Myersville samples had high CaEC (calcium exchange capacity) values (36 to 56 me/100g) even though they contained only 15% clay by the pipette method. The KEC (potassium exchange capacity) of these samples was only from 6 to 14 me/100g. The difference between the CaEC and KEC values is considered to be caused by K fixation by vermiculite in the samples. Using the difference and assuming that vermiculite has an exchange capacity of 154 me/100g the amount of vermiculite in the samples was estimated to be from 17 to 28%. Since these values are greater than the clay content of these soils it seems very likely that much of the vermiculite is present in the silt and sand fractions.

CaEC was determined for the Pocomoke and Sassafras samples with saturation by $CaCl_2$ as opposed to $Ca(OAc)_2$. CaEC values were about twice as large when $Ca(OAc)_2$ was used, but all values were much less (less than 10 me/100g in all cases) than with the Myersville soils. The difference between the $Ca(OAc)_2$ and $CaCl_2$ values may indicate considerable pH dependent CEC in these soils.

Removal of organic matter (H_2O_2 treatment) caused little change in the CEC of these B horizon samples. The free iron removal treatment generally increased the CEC values a small amount, but this may be partially caused by side effects of the treatment rather than an uncovering of exchange sites when the free iron is removed.

Table 1. Some characteristics of the soil samples studied.[1]

	Soil Horizon			
	Sassafras B2t	Pocomoke B22g	Myersville B2t	Myersville B2t
Soil Sample Lab No.	196	94	99	105
Clay content (%)	18.7	11.2	14.7	15.3
Organic C (%)	0.08	0.53	0.16	0.26
CEC (me/100g)				
By Sum cations	8.8	9.5	43.4	27.2
By NH_4OAc pH 7	5.5	5.4	17.6	16.0
pH (1:1 in H_2O)	5.2	4.8	6.0	6.4
Free Fe (%)	1.44	0.00	1.86	1.67

[1] Data from W. R. Wright's M. S. thesis.

Table 2. CEC values and vermiculite content of 2 Myersville B2t horizon samples as affected by H_2O_2 treatment (organic matter removal) and free iron removal.

Sample Lab No.	CaEC[1] me/100g	KEC[2] me/100g	CaEC-KEC me/100g	% Vr[3]
	Check, not H_2O_2 treated, free iron not removed			
99	50.6	10.5	40.1	26
105	36.5	6.4	30.1	20
	Not H_2O_2 treated, free iron removed			
99	55.5	13.2	42.3	27
105	40.1	12.8	27.3	18
	H_2O_2 treated, free iron not removed			
99	49.6	11.9	37.7	24
105	37.8	11.0	26.8	17
	H_2O_2 treated, free iron removed			
99	55.6	13.2	42.4	28
105	41.4	14.0	27.4	18

[1] Saturated with pH 7.4 $Ca(OAc)_2$, replacement with 1N $Mg(OAc)_2$. Each value is an average of duplicate determinations.

[2] Saturated with pH 7.4 KOAc, heated in 110C oven overnight after saturation, replaced with 1N NH_4OAc. Each value is an average of duplicate determinations.

[3] % Vr = $\frac{(\text{CaEC-KEC})\ 100}{154}$. Assumes that Vr (vermiculite) has a CEC of 154 me/100g and that this is entirely blocked by potassium. This is an estimate of the vermiculite content on a whole soil basis.

Table 3. Calcium exchange capacity of Sassafras and Pocomoke B horizon samples determined by $CaCl_2$ vs. $Ca(OAc)_2$ saturation as affected by H_2O_2 treatment (organic matter removal) and free iron removal. Values are averages of duplicate determinations.

	CaEC (me/100g)	
	$CaCl_2$ Saturation $MgCl_2$ Replacement	$Ca(OAc)_2$ Saturation $Mg(OAc)_2$ Replacement
Check, not H_2O_2 treated, free iron not removed		
Sassafras	2.4	6.4
Pocomoke	2.9	6.7
Not H_2O_2 treated, free iron removed		
Sassafras	4.4	7.5
Pocomoke	3.0	6.0
H_2O_2 treated, free iron not removed		
Sassafras	3.1	7.5
Pocomoke	2.3	4.9
H_2O_2 treated, free iron removed		
Sassafras	4.3	8.4
Pocomoke	2.9	5.4

Subsoil Fertility of Some Maryland Soils

J. E. Foss, W. R. Wright and V. A. Bandel
Department of Agronomy

Purpose and Objectives

This investigation is a part of the soil-characterization program which is responsible for studying the physical, chemical, and mineralogical characteristics of Maryland soils. Information on subsoil fertility in Maryland is very limited, and also, the importance of the available nutrients and pH levels below the plow layer or Ap horizon is not known. This preliminary study was designed to investigate the available P, K, Mg, and Mn levels and pH over a number of soil series from the three physiographic provinces of Maryland. The results of this study should provide an impetus for further investigations of the interaction between subsoil fertility and plant growth.

Procedures

Twenty soil series were selected for this study, and three modal profiles of each series were described and sampled according to standard procedures. Location and further description of soils in this study are given elsewhere.[1]

Soil pH was determined on a 1:1 soil-water ratio using a glass electrode on a Beckman pH meter. The "North Carolina" extracting solution (0.05N HCl and 0.025N H_2SO_4 mixture) was used to determine available P, K, Mg, and Mn. The soil-testing procedures are described fully in Agronomy Mimeo No. 37, 1969.

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[1] Wright, W. R. 1969. Contributions of Clay and Organic Matter to the Cation Exchange Capacity of Maryland Soils. M.S. Thesis. 103p.

Results

Table 1 shows the general distribution of pH values by physiographic province for samples from the surface plow layer (Ap horizon) and two subsurface depths (20 to 30 and 40 to 50 inches). The subsurface depths approximate the B2 and B3 or C1 horizons, respectively. In the Coastal Plain, the Ap horizons are quite acid with 73% of the samples having pH 6 or less and only 10% showing pH 5 or less. Subsoils, however, are extremely acid with 97% having pH values 6 or less and 57% pH 5 or less. Piedmont and Appalachian soils were generally not as acid as the Coastal Plain soils; however, subsoils in the Appalachian area had 60% of the samples with pH values less than 6.

The influence of lime applications is apparent in most Ap horizons. Figure 1 shows the pH distribution of 6 paired profiles from the Coastal Plain; these profiles were selected to show pH variation with depth after different liming intensities. As noted in other studies, lime (calcium) moves in the soil, but at slow rates. Brown et al.[1] noted that an application of 16 tons per acre of ground limestone affected the pH of a Paxton sandy loam to a depth of 30 inches after a period of 23 years. In Maryland the subsoil is apparently being recharged with small amounts of calcium to depths of 20 to 30 inches, the depth depending upon the amount of lime applied, the duration of the application and the texture of the soil. As illustrated in Table 1, however, most of the subsoils in the Coastal Plain are still very acid in spite of the liming practices of past years.

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[1] Brown, B. A. et al. 1956. Soil Reactions at Various Depths as Influenced by Time Since Application and Amounts of Limestone. Soil Sci. Soc. Am. Proc. 20:518-521.

Distribution of P_2O_5, K_2O, and Mn in the soil profiles shows a drastic decrease below the Ap horizon (Table 1). Over 90% of the subsoil samples had P_2O_5 contents less than 50 lbs./acre, and approximately 70 to 90% of the samples had K_2O levels of less than 80 lbs./acre. The distribution of these nutrients in Coastal Plain soils of different textures is illustrated in Figure 2. Sands and loamy sands are included in coarse textured soils while silt loams and silty clay loams are included in the medium and fine textured soils, respectively. Some movement of P and K is evident in the coarse-textured soils, but little movement is noted in the medium and fine-textured soils. Manganese contents of subsoils in the Appalachian and Piedmont regions were found to be higher than those of the Coastal Plain. These results are in agreement with those found earlier by Clark[1] for total Mn of soils in Maryland.

Magnesium contents of subsoils contrasted sharply with those of P, K, and Mn. Extractable Mg generally increased with depth in most soils; therefore, subsoils contained more Mg than the Ap horizons. The Mg appears to be correlated with the increased clay content of the B horizons. As noted on Figure 2, coarse-textured soils with little clay accumulation showed relatively constant amounts of Mg with depth.

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[1] Clark, L. J. 1954. The Determination and Distribution of Mn, Cu, Zn, and Mo in Thirteen Maryland Soils and Associated Rocks. Ph.D. Thesis. 101p.

Summary

Subsoils in Maryland are generally very acid and contain small amounts of available P_2O_5, K_2O , and Mn. Magnesium levels, however, are relatively high in subsoils of medium and fine textures. Although the significance of subsoil fertility is not known, the strongly contrasting conditions found in many of the soils studied may have important implications. With subsoils of extremely low pH and small amounts of P and K, consideration should probably be given to subsoil fertility in future soil test recommendations.

Table 1. Summary of pH values and available P_2O_5, K_2O, Mg, and Mn in soil profiles from the Coastal Plain, Piedmont, and Appalachian provinces.

Location	Depth in.	Percentage of Samples in Each Category																	
		pH					P_2O_5 lbs./Acre			K_2O lbs./Acre			Mg lbs./Acre			Mn lbs./Acre		
		4.0	4.1-5	5.1-6	6.1-7	7.1	0-50	51-135	136+	0-80	81-190	191+	0-45	46-105	106+	0-5	6-15	15+
Coastal Plain (N=30)[2]	0-10	0	10	63	23	3	13	17	70	40	43	17	10	13	77	2	23	70
	20-30	0	57	40	3	0	91	6	3	80	17	3	13	17	70	90	10	0
	40-50	3	53	40	3	0	93	7	0	73	27	0	30	13	60	80	17	3
Piedmont (N=15)	0-10	0	0	53	40	7	20	60	20	20	60	20	7	13	80	0	0	100
	20-30	0	0	27	73	0	93	0	7	93	7	0	7	20	73	13	33	54
	40-50[1]		--	--	--	-	--	--	--	--	--	--	--	--	--	--	--	--
Appalachian (N=15)	0-10	0	0	33	60	7	40	40	20	7	60	33	7	20	73	0	0	100
	20-30	0	40	20	27	13	100	0	0	73	27	0	27	27	46	20	13	67
	40-50[1]	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

[1] Insufficient number of profiles because of shallowness to bedrock.

[2] N = Number of soil profiles analyzed in each physiographic province.

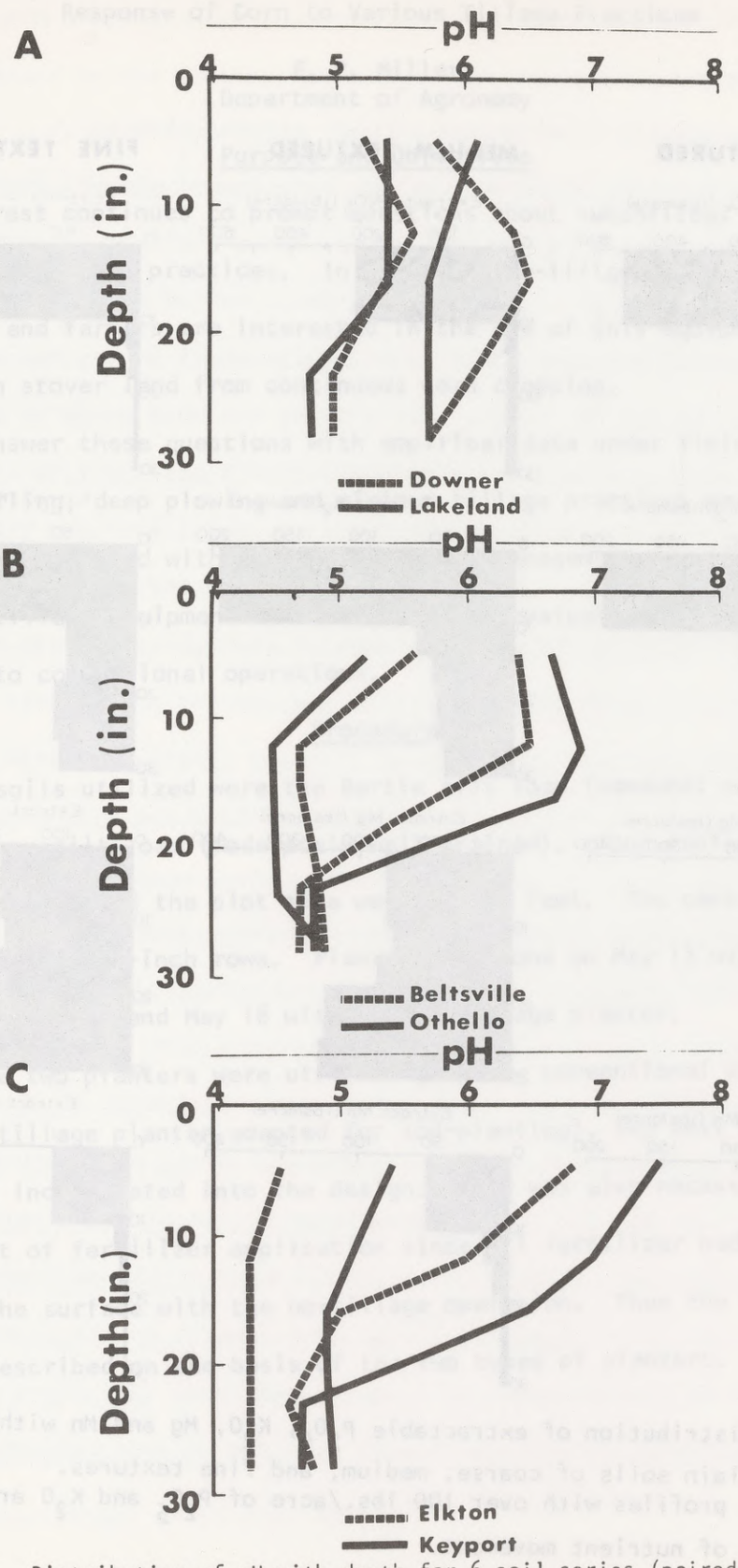

Figure 1. Distribution of pH with depth for 6 soil series (paired profiles) of the Coastal Plain. Textural classes are indicated by: A-Coarse textured, B-medium textured, and C-fine textured.

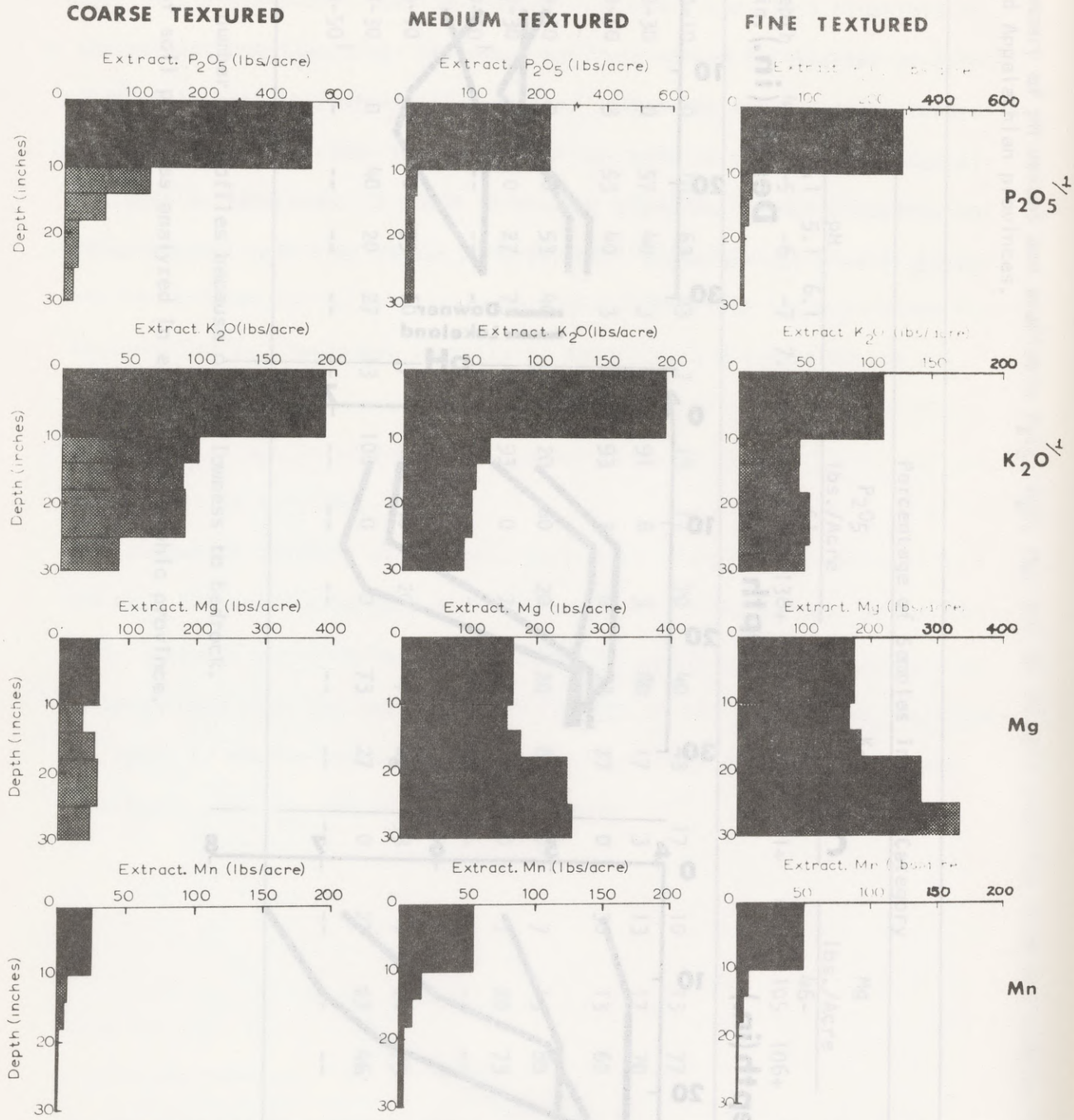

Figure 2. Distribution of extractable P_2O_5, K_2O, Mg and Mn with depth in Coastal Plain soils of coarse, medium, and fine textures.

1/ Only those profiles with over 100 lbs./acre of P_2O_5 and K_2O are plotted to show the extent of nutrient movement.

Response of Corn to Various Tillage Practices

F. P. Miller
Department of Agronomy

Purpose and Objectives

Interest continues to prompt questions about subsoiling, deep plowing, and minimum tillage practices. In addition, no-tillage equipment is now available and farmers are interested in the use of this equipment on unprepared corn stover land from continuous corn cropping.

To answer these questions with empirical data under field conditions, the subsoiling, deep plowing and minimum tillage practices were continued in 1969 and compared with conventional soil management practices. In addition, no-tillage equipment was introduced to evaluate its performance when compared to conventional operations.

Procedures

The soils utilized were the Bertie silt loam (somewhat poorly drained) and Mattapex silt loam (moderately well drained). Four replications were used throughout and the plot size was 50 x 20 feet. The corn variety was XL66 planted in 30-inch rows. Planting was done on May 13 with the conventional planter and May 16 with the no-tillage planter.

Since two planters were utilized (a 4-row conventional planter and a 2-row no-tillage planter adapted for sod-planting), two sets of check plots had to be incorporated into the design. This was also necessary from the standpoint of fertilizer application since all fertilizer had to be broadcast on the surface with the no-tillage operation. Thus the procedures will be described on the basis of the two types of planters.

A. The soil management practices which utilized the conventional 4-row planter were:

1. Check plot - moldboard plowed, disked, planted
2. Subsoiling at three spacings - moldboard plowed, disked, planted
3. Deep plowed (moldboard) at 12 inches - disked, planted
4. Plow planted - no disking, planted behind moldboard plow

Subsoiling was done April 4 at a depth of 23 inches and at three spacings of 22, 44 and 80 inches. All plowing was done on April 30.

Fertilizer was applied in accordance with soil test results and a yield goal of 150 bushels per acre. On April 30, fertilizer was broadcast at the rate of 144-80-80 (lbs. per acre of N-P_2O_5-K_2O) and plowed down. Fertilizer was applied in the planter at the rate of 13-50-50 (lbs. per acre of N-P_2O_5-K_2O). A combination herbicide was applied at the rate of 1 pound of atrazine (AATREX) and 1.5 pounds of alachlor (LASSO) per acre.

B. The no-tillage practices which utilized the 2-row no-tillage sod planter were:

1. Check plot - moldboard plowed, disked, planted
2. Disk-planted - no plowing, disked twice, planted
3. No-tillage - planted into last year's corn stover-chickweed land

The no-tillage plots had a very heavy infestation of chickweed. These plots were sprayed on May 12 with $\frac{1}{4}$ pound (1 pint) of paraquat to desiccate the weeds. On May 16, the aforementioned series of plots were planted with the no-tillage sod planter. Although the dead chickweed tended to hang up on the chisel which leads the double disk openers on the planter, there was no problem in planting into this unprepared land. All three treatments (check, disked only, and no-tillage) resulted in good uniform stands.

Since the sod planter had no fertilizer attachments, all fertilizer was broadcast on the surface for all treatments at the rate of 160-130-130 (lbs. per acre of N-P_2O_5-K_2O). The plots were then sprayed with the same atrazine-alachlor combination as used on the plots with the conventional planter.

Results

A. The results from the plots utilizing the conventional planter are presented in Table 1.

As in previous years, the subsoiling treatments have shown no better performance than the conventionally-prepared plot. In fact there has been a trend toward yield reductions but statistical analysis has indicated that these reductions are not significant and due only to experimental variation. However, in the case of the subsoiling treatment at the 80-inch spacing, the 27 bushel difference does prove to be significant. At the 5% level of significance, a difference of 20 bushels per acre was necessary to confirm a significant difference between treatments. No reason is readily apparent to explain this difference other than the possibility of compaction, but this observation is not noted in other subsoil spacings. One of the four reps yielded only 73 bushels per acre while the other three yielded 104, 107, and 129 bushels per acre. Eliminating this low rep would have brought the treatment average back to 113 bushels per acre and statistical analysis would, therefore, have indicated no difference from the check. Nevertheless, after three consecutive years of subsoiling these plots, no beneficial evidence in terms of corn production has been found.

Again as noted in previous years, the deep plowing and plow planting treatments yielded less than the check. Statistical analysis did not confirm a significant difference however.

B. The results from the plots utilizing the no-tillage sod planter are presented in Table 2.

These data indicate that in 1969, tilling the soil prior to planting with the no-tillage sod planter made no difference when compared to those plots which had not been plowed or disked. The no-tillage plots had not been touched since the corn was harvested from them in 1968. Thus, the surface of these plots contained last year's corn stover and whatever weeds and volunteer corn was present at the time paraquat was sprayed. Most of the weed vegetation consisted of a very rank growth of chickweed which almost completely covered the surface at the time of spraying. This growth provided a mulch which persisted into July. After July, the desiccated chickweed had decomposed almost beyond recognition.

The 136 bushels of corn per acre harvested from these plots were produced without any soil preparation prior to planting or subsequent cultivation. Two factors stand out as the major reasons for the success of this no-tillage production.

1. The leading chisel on the planter was very adequate to penetrate the soil to a depth of about 4 inches and stir the soil so that a 3-4 inch wide seedbed was prepared. The convex packer wheel trailing the double disk opener was very satisfactory in firming the soil. Thus, good soil-seed contact resulted and a uniform stand was obtained.
2. A good kill resulted from the paraquat application and the residual herbicide provided adequate weed control during the growing season. The chickweed "laid down" within a few days after it had been sprayed with paraquat. Thus, by the time the corn germinated and penetrated the soil surface, it was not shaded by the cover or

mulch crop and could take advantage of the sunlight. This problem has resulted in a retardation of early growth when taller and more dense cover crops are used or sprayed too late.

The rank chickweed growth did tend to hang up on the leading chisel as was mentioned previously. An attempt at correcting this problem will be made by installing a coulter ahead of the chisel to cut any dense sod or mulch material.

The silt loam soils used in this study have very poor structure and crust very badly after intense rains. The minimum of soil disturbance and moist conditions under the mulch were evidently enough to minimize the poor tilth and crusting of the soil surface.

The other plots which had been plowed and/or disked and subsequently cultivated twice did not show any advantage to these operations in this particular year.

The effect of the mulch on soil temperature, and consequently upon moisture conservation, can be illustrated by the data in Table 3. On June 2 the air temperature at 2 P.M. was 90°F while the surface inch soil temperature in the cultivated plots read 100°F and under the no-tillage mulched plots 84°F. As the growing season progressed, the effect of the chickweed mulch was reduced through decomposition. But the early influence of the mulch on the soil moisture was evidently enough to minimize the crusting characteristic of this soil.

Summary

For the third consecutive year corn yields from plots which had been subsoiled at three spacings, deep plowed and plow-planted showed no difference from the conventionally treated check plot. Although there was a trend toward yield reductions from the check by these treatments, statistical analysis indicated no significant difference.

The untreated plots which were sprayed with paraquat and planted with a no-tillage sod planter yielded 136 bushels per acre. There was no advantage to plowing and/or disking prior to planting with the no-tillage implement.

Table 1. Average corn yields for the period 1967-69 for five soil management treatments - Wye Institute.

Treatment	Average Yield bu./acre		
	1969	1968	1967
Check	130	118	112
Subsoiled 80 inches	103	105	115
Subsoiled 44 inches	123	116	115
Subsoiled 22 inches	113	98	112
Deep plowed (12 inches)	119	109	114
Plow-planted	120	98	---

Table 2. Average corn yields for no-tillage treatment as compared to conventional - Wye Institute.

Treatment	Average Yield bu./acre
Check	125
Disked only	131
No-tillage	136

Table 3. Soil temperatures at various depths of the no-tillage (mulch) and cultivated plots - Wye Institute.

Depth	June 2		June 5	
	Cult.	Mulch	Cult.	Mulch
	°F		°F	
Air temperature	90	90	81	81
1 inch	100	84	82	73
2 inches	94	82		
4 inches	84	78		
5 inches			72	69

Effect of Fall and Spring Plowing on Soil Aggregate Stability and Corn Yield Under Various Cropping Systems

E. Strickling
Department of Agronomy

Purpose and Objectives

To determine the effect of fall and spring plowing on soil moisture, soil aggregate stability, and corn yield under various cropping systems.

Procedures

One-half of each corn plot in a cropping system experiment on Beltsville silt loam is plowed each fall and the remaining half is plowed in April. This experiment includes long and short rotations as well as continuous corn with a rye-vetch cover crop. Soil samples were taken for soil moisture and soil aggregation determination.

Results

The crop yields are presented in Tables 1 through 4. Yields previous to 1967 are presented for purpose of comparison although all plots were spring plowed during this period. Soil aggregation and soil moisture data are shown in Table 5.

Summary

Fall plowing has had little effect on crop yield although soybean yields appear to have been depressed by fall plowing in 1967 and 1969. The 170 lbs. of nitrogen had about the same effect as 100 lbs. of nitrogen on all crops. Cropping systems have had large effects on corn and wheat yields. Aggregation was not affected by fall plowing but soil moisture was slightly higher in the spring plowed plots.

Table 1. Field corn yields in cropping system experiment.

Cropping*** System	Time of Plowing	1967 100 N bu./A	1967 170 N bu./A	1968* 100 N bu./A	1968* 170 N bu./A	1969 100 N bu./A	1969 170 N bu./A	Av. 1967-69 100 N bu./A	Av. 1967-69 170 N bu./A	Av.** 1959-66 100 N bu./A	Av.** 1959-66 170 N bu./A	Av.** 1952-58 100 N bu./A
Cont. C	Spring	134.0	140.6	25.8	30.2	117.0	110.8	92.2	93.9	53.6	61.9	72.6
	Fall	133.1	146.2	34.7	33.1	122.1	126.2	96.6	101.8	51.4	54.4	73.3
C□W	Spring	133.4	132.6	46.5	50.1	141.8	124.7	107.2	102.5	54.8	54.2	69.5
	Fall	132.4	137.1	38.7	37.2	129.2	121.5	100.1	98.6	51.9	51.9	75.6
CW	Spring	143.6	144.6	28.9	32.2	156.0	143.1	109.5	106.6	62.4	63.0	71.9
	Fall	145.1	146.8	41.3	40.7	141.4	147.7	109.3	111.7	64.0	61.2	70.8
CSW	Spring	155.8	151.6	41.4	49.9	148.9	135.8	115.4	112.4	62.7	62.1	73.4
	Fall	161.4	145.0	45.1	50.2	144.3	139.1	116.9	111.4	62.1	61.5	76.2
CWH	Spring	139.2	149.0	44.0	63.0	135.6	132.6	106.3	114.9	64.7	62.2	70.0
	Fall	142.0	153.3	63.1	63.2	137.3	146.5	114.1	121.0	66.9	65.5	76.1
CWHH	Spring	163.7	165.8	68.1	70.8	130.3	129.5	120.7	122.0	66.6	67.9	73.2
	Fall	169.9	165.4	73.4	74.5	141.6	138.7	128.3	126.2	66.5	69.2	79.6
CWPPP	Spring	156.8	169.4	54.1	60.6	126.0	146.7	112.3	125.6	69.6	71.4	72.6
	Fall	163.4	162.8	61.5	61.0	140.0	148.6	121.6	124.1	72.0	70.3	76.0
Av.	Spring	146.6	150.5	44.1	51.0	136.5	131.9	109.1	111.1	61.1	63.2	71.9
	Fall	149.6	150.9	51.1	51.4	136.6	138.3	112.4	113.5	62.1	62.0	75.4
	Av.	148.1	150.7	47.6	51.2	136.6	135.1	110.8	112.3	61.6	62.6	73.6

* Fall plowing was delayed until February by the weather.

** All plots were spring plowed previous to 1967. A soil conditioner was applied in 1952 on the plots that were fall plowed in 1967.

□ Corn stalks left on these plots.

***C = corn, S = soybeans, W = wheat, H = alfalfa hay, P = ladino clover-orchard grass.

Table 2. Wheat yield in cropping system experiment.*

Cropping System****	Time of Plowing	1968 100 N bu./A	1969 100 N bu./A	1970** 100 N bu./A	Av. 1968-70 bu./A	Av.*** 1953-67
Cont. W	No plow	11.2	29.2	13.5	18.0	31.7
	No plow	9.9	28.8	13.8	17.5	31.2
C▫W (stalks left)	Spring	10.0	24.2	34.4	22.9	33.1
	Fall	10.7	22.2	40.4	24.4	33.1
CW (stalks removed)	Spring	18.2	22.4	40.6	27.1	34.8
	Fall	18.0	20.5	40.9	26.5	34.3
SwC W	Spring	30.4	29.5	47.9	35.9	36.2
	Fall	25.4	28.2	43.9	32.5	36.6
CSW	Spring	21.7	32.9	50.1	34.9	37.6
	Fall	21.8	31.7	48.9	34.1	39.3
CSW	Spring	14.6	20.1	37.5	24.1	36.9
	Fall	19.2	22.2	43.4	28.3	36.9
CWHH	Spring	31.8	18.9	38.9	29.9	35.2
	Fall	28.1	19.5	37.6	28.4	36.4
CWPPP	Spring	17.4	25.5	39.0	27.3	35.1
	Fall	23.5	27.0	40.7	30.4	36.4
Av.	Spring	20.6	24.8	41.2	28.9	35.1
	Fall	20.9	24.5	42.3	29.2	35.2
	Av.	20.8	24.6	41.8	29.0	35.3

* Land was prepared for wheat by disking, spring and fall plowing for corn.

** Blueboy wheat used in 1970. Seneca used in previous years.

*** All plots were spring plowed for corn during this period.

▫ Corn stalks left on these plots.

****C = corn, SwC = sweet corn, S = soybeans, W = wheat, H = alfalfa, P = orchard grass-ladino clover

Table 3. Soybean yields in cropping system experiment.

Cropping*** System	Time of Plowing	Year 1967 bu./A	1968* bu./A	1969 bu./A	1967-69 (Av.) bu./A	1952-66 (Av.)** bu./A
Cont. Soybeans (W, cover)	Spring	56.2	19.8	36.8	37.6	22.1
	Fall	53.8	20.2	24.7	32.9	23.2
C, S, W	Spring	53.1	27.6	41.2	40.6	27.0
	Fall	47.5	31.7	37.1	38.8	27.1
Av.	Spring	54.65	23.7	39.0	39.1	24.5
	Fall	50.65	26.0	30.0	35.9	25.2
	Av.	52.65	24.8	34.9	37.5	24.8

* Fall plowing was delayed to February by weather.

** All plots were spring plowed from 1952 to 1966.

***C = corn, W = wheat, S = soybeans.

Table 4. Sweet corn yields in cropping system experiment.

Time of Plowing	1967		1968*		1969		1970		Av. 1967-70		Av.** 1959-66		Av.** 1952-58
	100 ton/A	170 ton/A	100 ton/A	170 ton/A	100 ton/A	170 ton/A	100 ton/A	170 ton/A	100 ton/A	170 ton/A	100 ton/A	170 ton/A	100
Spring	3.76	3.70	2.79	3.06	3.65	3.75	3.33	3.58	3.38	3.52	2.22	2.06	2.73
Fall	3.02	3.57	3.27	3.22	3.26	4.08	3.46	4.17	3.25	3.76	2.24	2.17	2.93
Av.	3.39	3.63	3.03	3.14	3.45	3.91	3.40	3.88	3.32	3.64	2.23	2.12	2.83

* Fall plowing was delayed until February by the weather.

**All plots were spring plowed previous to 1967. A soil conditioner was applied in 1952 on the plots that were fall plowed in 1967.

Table 5. Soil aggregation and soil moisture in fall and spring plowed plots in a cropping system experiment on Beltsville silt loam.

Cropping System	Aggregation				Soil Moisture	
	June, 1969		Average 1967-1969		June 10, 1969	
	Fall Plowed %	Spring Plowed %	Fall Plowed %	Spring Plowed %	Fall Plowed %	Spring Plowed %
Cont. Corn (stalks left Rye vetch cover)	12.8	18.0	12.9	15.4	18.4	18.8
Corn, Wheat (stalks left)	25.0	23.9	19.5	19.3	17.7	18.5
Corn, Wheat (stalks removed)	19.7	17.0	14.2	15.6	19.0	19.3
Sw. Corn, Wheat	21.7	19.0	16.5	16.7	17.8	18.2
Corn, Wheat, Hay	18.9	17.2	17.6	17.3	17.8	18.7
Corn, Soybeans, Wheat	17.5	20.0	15.3	16.7	18.2	19.4
Corn, Wheat, Hay, Hay	27.1	26.5	22.1	23.1	19.6	20.1
Corn, Wheat, 3 years Orchard Grass & Ladino Clover	36.4	34.2	30.9	31.8	18.6	20.7
Cont. Soybeans	10.5	9.8	8.0	7.2	17.5	18.1
Soybeans, Wheat, Corn	17.5	18.4	13.5	14.5		
Cont. Fallow	5.1	7.4	5.0	5.5	14.8	16.3
Average	19.3	19.2	15.9	16.7	18.0	18.8

Moisture Loss from Alfalfa, Bluegrass and Bare Fallow

C. K. Stottlemyer and E. Strickling
Department of Agronomy

Purpose and Objectives

With the increasing acreage of land being irrigated, the demand for knowledge of moisture loss from crops is increasing. The purpose of this study was to compare moisture loss from alfalfa, bluegrass and bare fallow plots on Chester and Manor soils. In addition several equations for predicting evapotranspiration were compared with measured soil water loss.

Procedures

Neutron moisture readings were taken at eleven depths from June 10 to September 26, 1963, and from May 5 to September 24, 1964, at two or three-day intervals. Climatological data were collected to be used in potential evapotranspiration equations. The 15 atmosphere soil moisture percentages were determined in the laboratory on soil samples taken to a depth of 51 inches from each plot.

Results

Tables 1 and 2 show meteoroligical data, run-off (calculated) as well as the average daily soil water depletion as calculated by the Thornthwaite, Kohler and radiation x.0007 equations for alfalfa and bluegrass plots on Chester and Manor soils in 1963 and 1964 respectively. The moisture loss from alfalfa, bluegrass and bare fallow plots on Chester and Manor soils in 1963 and 1964 growing seasons are listed in Table 3.

Summary

Alfalfa and bluegrass plots lost water at similar rates and the bare fallow plots lost less water than alfalfa or bluegrass plots. Alfalfa was able to deplete soil moisture from deeper depths than bluegrass. Alfalfa

and bluegrass wilted during part of the day even though available water was within 15.2 cm of the soil surface. The depletion rates decreased when the plants wilted.

The Kohler and the solar radiation x.0007 equation gave accurate predictions of total soil water in the top 51 inches of the soil when they were combined with a soil moisture bookkeeping procedure. This procedure subtracted daily evapotranspiration (as calculated from meteorological data by the equations) from the total water in the soil profile. Rainfall (adjusted for run-off) was added to the total soil water. When the total soil water was reduced to 80% of the total water held at field capacity the daily removal was reduced by multiplying the calculated evapotranspiration by the percent of available water remaining in the soil profile. This was necessary because wilting of the plants reduced the loss of water by evapotranspiration. During extreme wilting of the plants the plots only lost about 1/3 as much water as when the plants were turgid. The Thornthwaite equation underestimated the soil moisture depletion early in the growing season and overestimated the soil moisture depletion during the middle of the growing season.

A difference in soil moisture depletion between the Chester soil and the Manor soil was obtained, probably due to climatological differences in the sites. Wilting point determinations made in the laboratory were not good estimates of wilting point in the field. Considerable amounts of water were lost via run-off during periods of intense rainfall.

Table 1. Average daily meteorological data, total rainfall, calculated run-off and average daily soil water depletion as calculated by the Thornthwaite, Kohler and radiation x .0007 equations for alfalfa and bluegrass plots on Chester and Manor soils in 1963.

Period	Avg. Daily Solar Radiation	Avg. Daily Dew Pt.	Avg. Daily Max. and Min. Temp.	Avg.[1] Open-Pan Evap.	Avg. Daily[2] Depletion in Alf. and Blue.	Avg. Daily Soil Water Depletion by			Total Rainfall	Calcu-[3] lated Run-off
						Thorn-thwaite	Kohler	Rad. x .0007		
days	lang./day	°C	°C.	cm./day	cm./day	cm./day			cm.	cm.
6/10-6/22	499	13	27-13	0.74	0.35	0.40	0.36	0.35	2.97	
6/22-7/4	628	16	31-14	0.53	0.46	0.47	0.49	0.44	0.58	
7/4-7/16	552	13	28-12	0.64	0.32	0.39	0.41	0.39	2.03	
7/16-7/28	550	19	32-17	0.66	0.24	0.52	0.43	0.38	0.91	
7/28-8/9	490	17	31-17	0.64	0.23	0.50	0.39	0.35	0.61	
8/9-8/21	471	15	29-13	0.69	0.24	0.40	0.34	0.33	10.01	4.42
8/21-9/2	463	16	27-14	0.48	0.25	0.36	0.30	0.33	2.62	
9/2-9/14	386	14	26-12	0.36	0.20	0.31	0.23	0.27	0.58	
9/14-9/26	325	9	20-8	0.36	0.18	0.24	0.17	0.23	3.78	

[1] Measurements taken with a Weather Bureau Class A Open-Pan at Beltsville, Maryland.

[2] All rainfall was assumed to have infiltrated in all periods except in rainy period 8/9 to 8/21 when some run-off occurred. Nine days of depletion in this period was estimated with Kohler's equation.

[3] Run-off was calculated from rainfalls greater than 2.79 cm. by subtracting the soil moisture recharge as measured by the neutron probe plus the evapotranspiration between meter readings as calculated by Kohler's equation from the total rainfall between meter readings.

Table 2. Average daily meteorological data, total rainfall, calculated run-off and average daily soil water depletion as calculated by the Thornthwaite, Kohler and radiation x .0007 equations for alfalfa and bluegrass plots on Chester and Manor soils in 1964.

Period	Avg. Daily Solar Radiation	Avg. Daily Dew Pt.	Avg. Daily Max. and Min. Temp.	Avg.[1] Open-Pan Evap.	Avg. Daily[2] Depletion in Alf. and Blue.	Avg. Daily Soil Water Depletion by			Total Rainfall	Calcu-[3] lated Run-off
						Thorn-thwaite	Kohler	Rad. x .0007		
days	lang./day	°C	°C	cm./day	cm./day	cm./day			cm.	cm.
5/5-5/17	491	11	24-8	0.52	0.41	0.29	0.31	0.34	0.99	
5/17-5/29	616	11	28-11	0.67	0.38	0.34	0.45	0.43	0.25	
5/29-6/10	505	11	24-9	0.50	0.33	0.32	0.34	0.36	1.40	
6/10-6/22	578	16	31-15	0.69	0.36	0.47	0.46	0.41	4.06	
6/22-7/4	553	18	31-17	0.62	0.41	0.50	0.44	0.39	3.18	
7/4-7/16	502	16	29-14	0.58	0.38	0.44	0.36	0.35	4.19	
7/16-7/28	384	20	29-18	0.51	0.15	0.50	0.27	0.27		
7/28-8/9	477	16	29-15	0.55	0.22	0.44	0.36	0.34	4.75	1.40
8/9-8/21	428	13	26-12	0.47	0.18	0.34	0.28	0.30	0.84	
8/21-9/2	403	18	31-18	0.49	0.18	0.45	0.29	0.28	0.46	
9/2-9/14	455	12	30-10	0.64	0.11	0.34	0.33	0.32	0.58	
9/14-9/26	370	11	25-10	0.42	0.15	0.28	0.23	0.26	1.65	

[1] Measurements taken with a Weather Bureau Class A Open-Pan at Beltsville, Maryland.

[2] All rainfall was assumed to have infiltrated in all periods except in rainy period 8/9 to 8/21 when some run-off occurred. Nine days of depletion in this period was estimated with Kohler's equation.

[3] Run-off was calculated from rainfalls greater than 2.79 cm. by subtracting the soil moisture recharge as measured by the neutron probe plus the evapotranspiration between meter readings as calculated by Kohler's equation from the total rainfall between meter readings.

Table 3. Moisture loss from alfalfa, bluegrass and bare-fallow plots on Chester and Manor soils in 1963 and 1964.

Crop or Soil	Average total water lost during the indicated growing season for alfalfa, bluegrass and bare-fallow on the Chester and Manor soils	
	1963[1] 6/10-9/26	1964[2] 5/5-9/26
	cm.	cm.
Alfalfa	31.50	41.40
Bluegrass	28.70	38.61
Bare-fallow	23.37	29.97
Chester	27.18	36.58
Manor	28.45	36.83

[1] Bare-fallow plots lost significantly less water than bluegrass or alfalfa plots, and bluegrass plots lost significantly less water than alfalfa plots.

[2] Bare-fallow plots lost significantly less water than bluegrass or alfalfa plots.

CROPS & SOILS RESEARCH 1970

DEPARTMENT OF AGRONOMY
AGRICULTURAL EXPERIMENT STATION
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INTRODUCTION

Research Program in Department of Agronomy

This report gives the research in progress in the Department of Agronomy. The purpose of the research program in the Department is to develop improved crop varieties and improved soil and crop management practices that result in more efficient crop production. Of equal importance is the development and application of principles of soil and water use and conservation. Investigations of the fundamental principles of genetics, physiology, and bio-chemistry of crops and the nature and properties of soils are major objectives of the Department of Agronomy. Results from the basic research are applied to the practical problems of agronomic nature.

The wide range of soils and 2.3 million acres of agronomic crops (corn, soybeans, tobacco, small grain, turfgrasses, hay, and pasture) grown in the state with a value of approximately 168 million dollars emphasize the size and importance of the research program in agronomy. To solve crops and soils problems research work is conducted at University Laboratories, on the outlying Experiment Station Farms, and cooperatively with farmers, golf course superintendents, and others throughout the state.

James R. Miller
Head, Department of Agronomy

Director, Maryland Agric. Expt. Sta.

Evaluation of Yield and Quality Characteristics of Tall Fescue and Orchardgrass

K. A. Archer and A. M. Decker
Department of Agronomy

Purpose and Objectives

Tall fescue and orchardgrass have been utilized extensively in temperate climates throughout the world as both pasture and hay crops. However, due to variations in climatic conditions and soil fertility, particularly nitrogen availability, the growth rates and quality of these species vary considerably throughout the year.

The objectives of this research are to evaluate and compare growth and quality characteristics of these two species grown under different nitrogen fertilization regimes. Particular emphasis is being placed on the period from September to December to determine the potential value of these species for inclusion in autumn-saving management regimes as means of supplying forage during late autumn and early winter.

A major aspect of this research is to investigate relationships among some of the many parameters which have been proposed to estimate or predict forage quality.

Further studies are planned to investigate the influence of soil temperature on the factors mentioned above.

Procedures

Two species (orchardgrass and tall fescue) and three rates of nitrogen (0, 50 and 100 Kg N/Ha) were the treatments used in the field study. The experimental design was a randomized complete block with 4 replications.

In mid-September, 1970, the plots were cut to 6.4 cm and the nitrogen fertilizer treatments were applied. Three samples, each 1.5 square meters in area were harvested from each plot at intervals of approximately five weeks during fall and early winter; the final sample being taken on December 24. The purpose was to sample in a serial fashion during this period to determine the pattern of change within the standing pasture.

By weighing, subsampling and sorting, the following data were obtained: dry matter yield, yield of green fraction, yield of the dead fraction and the percentages of the green and dead materials in the pasture.

Each of the two fractions plus an unsorted sample was ground through a 20 mesh screen prior to laboratory analysis to determine the percentages of acid detergent fiber, lignin, cellulose, hemicellulose, silica, cell walls, cell solubles, nitrogen and in vitro digestibility.

Results

At the time of this writing, only half of the laboratory analyses have been completed and for this reason only yield data will be presented (Tables 1 and 2).

Dry matter production was substantial during the early fall reaching over 3,000 Kg dry matter/ha by mid-November (Table 1). However, during the following month, available dry matter declined by an average of approximately 600 Kg/ha. This decline was apparently the result of very low growth rates and high death rates of leaves caused by the low temperatures experienced during December. Tall fescue produced higher yields than orchardgrass and, although the yield of dead material was similar for both species during the late fall, the dead material fraction made up a significantly higher percentage of the sward in the orchardgrass plots. Also,

the higher yield of green material in the tall fescue plots would indicate that this species is to be preferred over orchardgrass for autumn-saving purposes.

Application of nitrogen fertilizer increased total available dry matter of both species during late fall and also increased the percentage and yield of green fraction of the pastures (Table 2).

Preliminary observations on the laboratory data obtained show a definite increase in the percentages of acid detergent fiber, lignin and silica contents with successive sampling during the fall. These fractions made up a higher percentage of the dry matter in the dead leaves compared with the green leaves in the pasture. As fiber, lignin and silica contents are closely related to quality, this would indicate that orchardgrass is less digestible than tall fescue during the autumn period. However, the in vitro digestibility data will be required before any definite conclusions can be drawn on the quality aspects of this study.

Summary

1. Total dry matter production from tall fescue was greater than from orchardgrass during the fall.
2. Tall fescue pastures contained a higher percentage of green leaves than orchardgrass.
3. Nitrogen fertilizer applications increased total dry matter production and maintained a higher proportion of green leaves in the pasture.
4. Preliminary results indicated that tall fescue is more digestible than orchardgrass during the autumn period and would therefore be preferred for autumn pasture.

Table 1. Dry matter yield data of orchardgrass and tall fescue harvested at three dates during autumn and early winter.

Yield Parameter	Harvest Dates								
	October 12, 1970			November 17, 1970			December 24, 1970		
	Orch.	Fescue	Av.	Orch.	Fescue	Av.	Orch.	Fescue	Av.
Total Dry Matter Yield (Kg/ha)	2290[a] 1/	2084[a]	2155	3096[a]	3635[b]	3365	2449[a]	3052[b]	2750
Dry Yield Green Fraction (Kg/ha)	1894[a]	1866[a]	1881	2245[a]	2839[b]	2541	1297[a]	1857[b]	1577
Dry Yield Dead Fraction (Kg/ha)	396[a]	218[b]	307	851[a]	796[a]	823	1152[a]	1195[a]	1173
Percentage Green Fraction	82.7[a]	89.5[b]	87.3	72.5[a]	78.1[b]	75.5	53.0[a]	60.8[b]	56.6
Percentage Dead Fraction	17.3[a]	10.5[b]	14.2	27.5[a]	21.9[b]	24.4	47.0[a]	39.1[b]	42.7

1/ Means with the same letter within each harvest date are not significantly different at the 5% level.

Table 2. Effects of nitrogen fertilizer application (0, 50 or 100 Kg N/ha) on dry matter yields harvested at three dates during autumn and early winter.

Yield Parameter	Harvest Dates								
	October 12, 1970			November 17, 1970			December 24, 1970		
	0	50	100	0	50	100	0	50	100
Total Dry Matter Yield (Kg/ha)	2056[a] 1/	2356[a]	2152[a]	2957[a]	3454[b]	3684[b]	2250[a]	2850[b]	3142[b]
Dry Yield Green Fraction (kg/ha)	1761[a]	2022[a]	1860[a]	2141[a]	2643[b]	2840[c]	1171[a]	1604[b]	1956[c]
Dry Yield Dead Fraction (Kg/ha)	295[a]	334[a]	292[a]	816[a]	811[a]	844[a]	1079[a]	1254[a]	1186[a]
Percentage Green Fraction	85.7[a]	85.8[a]	86.4[a]	72.4[a]	76.5[b]	77.1[b]	52.0[a]	56.1[a]	62.2[b]
Percentage Dead Fraction	14.3[a]	14.2[a]	13.6[a]	27.6[a]	23.5[b]	22.9[b]	48.0[a]	43.9[a]	37.8[b]

1/ Means with the same letter within each harvest date are not significantly different at the 5% level.

Breeding for Black Shank and Mosaic Resistance in Maryland Tobacco

M. K. Aycock, Jr.
Department of Agronomy

Purpose and Objectives

A number of diseases attack tobacco grown in southern Maryland; therefore, a large part of the breeding program at the University of Maryland is concerned with disease resistance. At the present time the tobacco mosaic virus appears to be the most destructive disease and until recently, none of the varieties being grown had mosaic resistance. However in 1969, Md. 10, a new Catterton-type mosaic resistant variety was released jointly by the U. S. Department of Agriculture and the Agricultural Experiment Station (Skoog, H. A. and M. K. Aycock, Jr. 1969. Agr. Exp. Sta. Mis. Pub. No. 734). Other diseases which cause some loss in Maryland tobacco each year are black root rot (*Thielaviopsis basicola*), wildfire (*Pseudomonas tabaci*), black shank (*Phytophthora parasitica* var. *nicotianae*), and fusarium wilt (*Fusarium oxysporum* var. *nicotianae*). At present the tobacco breeding program is concerned with developing varieties with resistance to two diseases -- tobacco mosaic and black shank.

Procedures

Breeding for Black Shank Resistance. The source of resistance to black shank presently being used is from Md. 59 and Md. 609 which are two varieties released in 1965. These two varieties were developed by Dr. O. D. Morgan, and the source of black shank resistance was from Florida 301.

During January and February, 1970 a modification of a black shank screening procedure utilized at the University of Kentucky was used to screen approximately 108 entries in the F_2 to F_8 generations. The procedure involved plant-

ing approximately 10 to 15 seeds of an entry in a vermiculite-filled 50 ml polypropylene centrifuge tube. About 4 weeks after seeding the seedlings were inoculated with the black shank fungus. Two weeks after inoculation the entries were scored on above ground plant parts (leaves and stems) and the roots. A scoring system of 0, 1, 2, 3 and 4 was utilized for the leaves and stems with a score of 0 representing no symptoms of the disease and a score of 4 representing complete death of all seedlings. A similar system was used for the roots symptoms with 0 representing no symptoms (roots white) and 4 representing severe browning of the entire root system.

Breeding for Mosaic Resistance. During December, 1969, 108 entries in the F_2 to the F_8 generations were screened for mosaic resistance. Each entry was represented by 10 plants. Seedlings which were approximately 2 months old were inoculated with the tobacco mosaic virus by rubbing the leaf with cheesecloth saturated in a solution of the virus. Approximately one week after inoculation, readings were made on the number of resistant and susceptible plants in each entry. At the time of scoring the resistant plants exhibited small necrotic spots at the cite of inoculation while the susceptible plants exhibited the characteristic mosaic pattern of dark and light green areas in the new growth. The necrotic spots of the resistant plants are due to a hypersensitive reaction of the leaf tissue to the virus. When the virus contacts the leaf cells, the cells die at such a rapid rate that the virus cannot spread.

Results

Black Shank Resistance. The results of the screening procedure for black shank resistance are presented in Figure 1. Considerable variation was found among the entries for black shank resistance. A few entries appeared to have complete resistance while others were completely susceptible. From

the leaf and stem scores, 42.6% of the entries received a score of 1.5 or better while 35.1% of the root scores fell within this same range. Entries with a score of 1.5 would probably have adequate resistance under field conditions in southern Maryland.

One reason for the wide variation among the entries for black shank resistance could be due to the nature of inheritance of the resistance. Resistance is believed to be dependent upon two major genes and several modifiers; therefore, through breeding the ultimate objective is to capture the two major genes and accumulate as many of the modifiers as possible.

Mosaic Resistance. The results of the tobacco mosaic screening procedure are shown in Figure 2. Resistance is determined by a single dominant gene; therefore, the plants fell into one of two classes -- resistant or susceptible. Approximately 99.1% of the entries were resistant. For the resistant entries, 20.6% appeared to be homozygous or true breeding and 79.4% were heterozygous or still segregating at the mosaic resistant locus.

Summary

Breeding lines with resistance to black shank and tobacco mosaic are being developed. Screening techniques which are relatively simple and reliable are being used in the greenhouse. Lines with good resistance based on greenhouse results were advanced an additional generation in the field nursery during the summer. Selection for plant type and other desirable agronomic traits was done in the field nursery.

Some of the breeding lines which have good resistance and desirable plant types have been observed in preliminary field trials under replicated conditions.

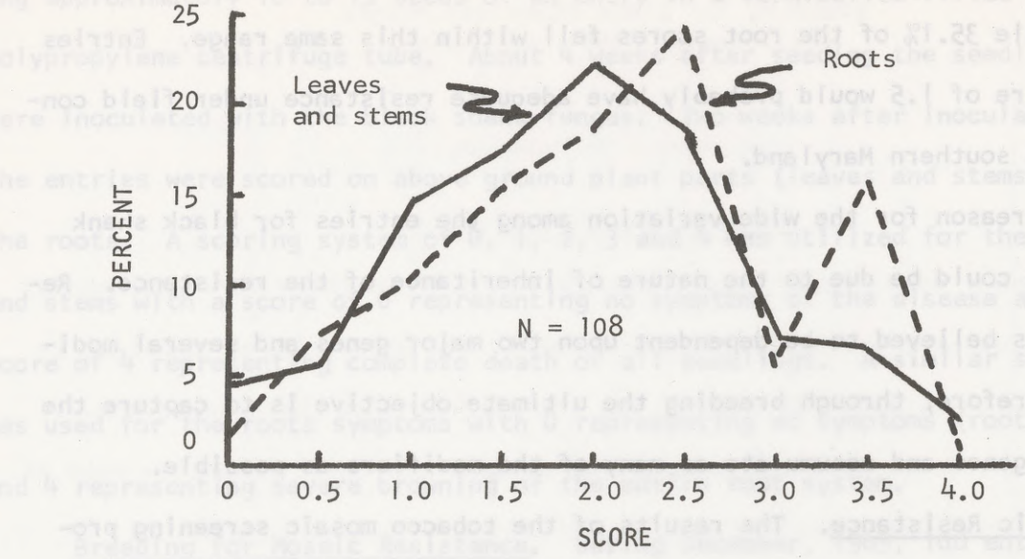

Figure 1. Frequency distribution of entries screened for black shank resistance; 0 = completely resistant and 4 = dead. (1970)

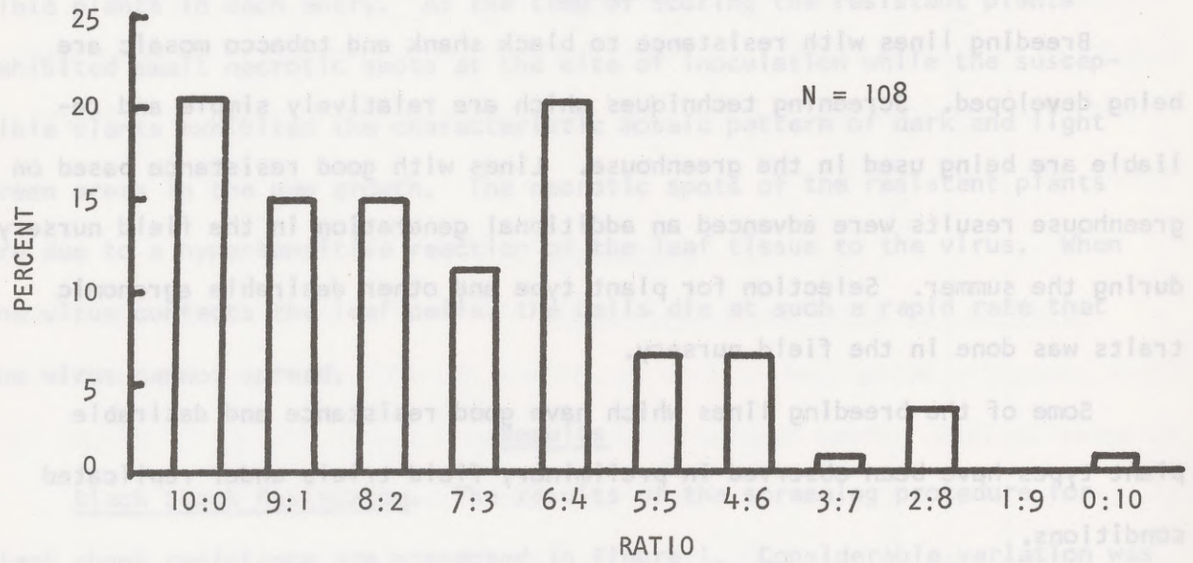

Figure 2. Frequency distribution of entries screened for tobacco mosaic resistance. The ratio is expressed as the number of resistant plants to the number of susceptible plants. (1970)

Performance of Maryland Tobacco Varieties and Breeding Lines, 1969

M. K. Aycock, Jr.
Department of Agronomy

Purpose and Objectives

The Official Variety Test is the final phase of the breeding program and has three main objectives: (1) To obtain additional information on the varieties presently being grown by the majority of the tobacco farmers, (2) to evaluate advanced breeding lines which appear to have potential as a new variety, and (3) to provide a guide to southern Maryland tobacco farmers for use in choosing a variety to produce their best crop.

Procedures

Each year the variety tests are conducted at three locations with varying soil types. At Upper Marlboro, Davidsonville and Dentsville the tests are grown on Monmouth fine sandy loam, Galestown loamy sand and Beltsville silt loam soils, respectively.

The 1969 test which is included in the present report contained seven varieties and nine breeding lines. Seven breeding lines in the test were developed by the USDA at Beltsville under the direction of H. A. Skoog. M871 and M872 were Agricultural Experiment Station entries.

Four replications of a randomized complete block design were used at each location. Each plot consisted of one row of 23 competitive plants. The plots were three feet apart and plants spaced two feet apart in the plot. Twenty competitive plants per plot were cut at harvest.

The various agronomic and chemical characteristics measured and methods of data collection have been outlined by Aycock *et al.*, 1968, Md. Agr. Exp. Sta. Mis. Pub. 662.

Results

The average performance of the varieties and breeding lines compared at three locations in 1969 is shown in Table 1. Md. 64 was the highest yielding variety with 1987 pounds of cured leaf per acre. Md. 609 was the best quality variety with an average of $70.86 per hundredweight. Several breeding lines compared very favorably with the best varieties. J-68-102F-1 and J-68-205F-3 were similar to Md. 64 in yield and also gave a high dollar return per acre. M871 and M881 were slightly lower in yield than Md. 64, but produced a good quality leaf that was similar to Md. 609. Good yields and high quality for these two breeding lines resulted in a high dollar return per acre.

The varieties and breeding lines ranged from 1.23% (J-68-102F-1) to 2.07% (J-68-31F-1) for total alkaloids. It is interesting to note that several breeding lines have a lower total alkaloid content than the varieties. For example, M871 and M881 were derived from a cross involving Md. 609 as one of the parents, and these two lines are considerably lower in total alkaloids than Md. 609.

Summary

The variety testing program was conducted at three locations in 1969. Several breeding lines with multiple disease resistance appear to have a real potential as new varieties.

Table 1. Performance of Maryland tobacco varieties and breeding lines at three locations, 1969.

Variety or breeding line	Yield per acre (lbs.)	Value $/A	Value $/cwt.	Plant height (in.)	Leaves per plant	Internode length (in.)	Days to flower	Total alkaloids (%)	Total nitrogen (%)	Duration of burn (sec.)	Filling capacity (cc/g)
Catterton	1532	993	65.10	33.4	20.4	1.64	48.6	1.34	2.38	11.1	7.23
Wilson	1881	1100	58.99	33.2	19.8	1.68	54.8	1.33	2.54	12.4	6.73
Gertz	1480	911	61.74	32.8	19.3	1.69	51.0	1.75	2.52	10.7	6.23
Md. 59	1564	1099	70.37	36.3	18.6	1.95	51.8	1.61	2.31	11.8	6.87
Md. 609	1656	1170	70.86	33.7	18.7	1.80	57.7	1.72	2.54	12.5	6.56
Md. 64	1987	1236	62.84	33.4	21.0	1.57	57.8	1.35	2.45	11.2	6.66
Md. 10	1502	993	66.24	34.0	20.6	1.65	51.2	1.36	2.18	11.3	6.98
M871	1848	1271	69.08	34.0	19.0	1.78	55.9	1.28	2.51	11.3	6.71
M881	1883	1275	67.89	37.1	19.3	1.92	54.2	1.38	2.22	11.8	6.56
J-68-31F-1	1459	1006	69.13	33.7	17.8	1.89	48.7	2.07	2.60	8.1	6.66
J-68-45F-1	1463	1021	69.68	33.5	19.0	1.76	51.6	1.93	2.54	10.1	7.00
J-68-102F-1	1932	1161	60.57	35.7	20.2	1.77	57.7	1.23	2.38	13.3	6.77
J-68-201F-1	1867	1278	68.52	33.8	21.2	1.61	54.8	1.56	2.42	11.2	7.05
J-68-205F-3	1967	1319	67.12	35.5	21.6	1.64	59.7	1.46	2.51	11.8	6.85
J-68-221F-1	1835	1180	64.56	36.4	19.9	1.83	54.0	1.26	2.42	12.6	6.57
J-68-223F-1	1827	1235	67.94	39.2	21.3	1.85	58.1	1.48	2.40	13.4	6.79
Mean	1730	1140	66.29	34.7	19.8	1.75	54.2	1.51	2.43	11.6	6.76
L.S.D. (.05)	134	106	3.85	3.0	1.3	0.09	4.0	0.31	0.23	2.4	0.44
(.01)	180	143	5.19	4.1	1.8	0.13	5.4	0.41	N.S.	N.S.	N.S.
C.V. (%)	7.0	8.4	4.8	6.7	6.4	4.3	4.7	16.5	10.6	19.4	6.9

Performance of Maryland Tobacco Breeding Lines in the Preliminary Variety Test, 1970

M. K. Aycock, Jr.
Department of Agronomy

Purpose and Objectives

The initial phase of a breeding program is developmental. Following a desired cross or series of crosses, selection for superior lines is conducted for a number of segregating generations. As new lines reach homozygosity information concerning agronomic and chemical performance is needed. The preliminary variety test is the initial screening process for new breeding lines. Superior breeding lines in this test are then included in the Official Variety Test for further evaluation.

Procedures

In 1969 a group of near homozygous lines with resistance to black shank and/or tobacco mosaic were selected from the tobacco breeding nursery for yield and quality evaluations. These breeding lines were tested in 1970 at Upper Marlboro.

Seventeen breeding lines and three standard varieties (Md. 10, Md. 609, and Md. 64) were included in the test. The experimental design was a randomized complete block with three replications.

Results

The performance of 17 breeding lines and three standard varieties is shown in Table 1. M721, M741 and M833 appeared to be the most promising breeding lines in the test. They compared favorably with Md. 609 for both yield and quality. Considerable variation was observed among the other breeding lines and in comparison with the standard varieties. The top breeding lines from this test will be advanced to the Official Variety Test, and also used as breeding material in future crosses.

Summary

The performance of three breeding lines (M721, M741 and M833) was very good when compared with the standard varieties. These breeding lines will be advanced to the Official Variety Test, and also used as breeding material in future crosses.

Table 1. Performance of advanced breeding lines of Maryland tobacco in a preliminary variety trial at Upper Marlboro, Md., 1970.

Entry	Yield per acre (lbs.)	Value		Plant height (cm)	Leaves per plant	Internode length (cm)	Days to flower	Total alkaloids (%)	Total nitrogen (%)
		$/A	$/cwt.						
M451	1075	771	71.67	81.0	18.2	4.44	55.0	0.82	2.38
M452	1184	857	72.27	75.5	17.9	4.24	56.7	0.85	2.18
M491	1204	873	72.47	75.2	16.8	4.47	55.0	0.92	2.34
M492	1045	755	72.25	71.0	17.4	4.08	57.3	1.05	2.20
M511	1183	830	70.08	85.3	19.2	4.44	52.7	1.17	2.72
M512	1105	762	68.83	73.3	16.4	4.47	56.7	0.74	2.34
M721	1672	1270	75.98	79.5	17.2	4.63	53.7	1.06	2.57
M722	1311	981	74.65	72.6	16.8	4.31	56.3	0.76	2.26
M731	1241	895	72.20	61.9	16.2	3.82	53.3	0.69	2.49
M732	1516	1117	73.58	68.4	16.6	4.12	54.7	0.96	2.31
M733	1607	1179	73.25	75.2	18.1	4.15	54.3	0.97	2.67
M741	1676	1252	74.57	74.0	18.0	4.12	56.3	0.84	2.66
M742	1493	1101	73.73	59.5	16.1	3.69	57.3	0.88	2.34
M831	1305	940	72.04	64.6	16.3	3.95	54.3	0.81	2.20
M832	1125	814	72.17	61.4	15.0	4.08	54.3	0.58	2.29
M833	1661	1263	75.48	79.2	16.9	4.65	55.3	0.92	2.86
M834	1542	1145	73.76	88.0	18.6	4.75	54.3	0.70	2.44
Md. 10	1405	1044	73.93	74.1	18.4	4.01	55.7	0.99	2.45
Md. 609	1473	1142	77.48	70.2	16.8	4.17	55.7	0.91	2.40
Md. 64	1247	891	71.40	56.9	16.7	3.41	58.3	0.57	2.30
Mean	1353	994	73.09	72.3	17.2	4.20	55.4	0.86	2.42
L.S.D. (5%)	391	320	2.91	14.6	N.S.	0.43	2.6	0.32	N.S.
(1%)	524	429	3.91	19.6	N.S.	0.58	3.4	N.S.	N.S.
C.V. (%)	17.5	19.5	2.4	12.2	9.1	6.2	2.8	22.6	11.7

Growth and Flowering of Johnsongrass Selections Under Different Dark Periods

G. W. Burt
Department of Agronomy

Purpose and Objectives

Johnsongrass (Sorghum halepense (L.) Pers.) remains one of the ten most troublesome weeds in the United States and the World (Holm, L. 1969. Weed Sci. 17:113-118) despite continued control efforts. Understanding of the environmental parameters of growth is important in man's attempt to learn how to control this rapidly spreading, competitive species.

Growth chamber studies have shown that johnsongrass produces more fresh weight at high temperatures and flowers more rapidly at intermediate photoperiod (Ingle, M. and B. J. Rodgers. 1961. Amer. J. Bot. 48:392-396). A 12-hour photoperiod was noted by these workers to be optimum for johnsongrass dry matter accumulation and flowering. They assumed that rhizome growth was related to vegetative topgrowth and not specifically to flowering. They also assumed that the photoperiodic response was quantitative rather than qualitative because limited flowering occurred at a 16-hour photoperiod. Sakri and Hull (1968. Plant Physiol. 43 (Suppl):S-5) concluded that growth stage and photoperiod were the most important factors in rhizome initiation and growth. Length of the uninterrupted dark period has long been recognized as more critical to flowering than the light period (Hammer, K. C. and J. Bonner. 1938. Bot. Gaz. 100:388-431) because of the phytochrome system. Past photoperiodic studies with johnsongrass have not, however, examined this important factor (or the influence in light quality) in growth and development.

The present study was initiated to determine the influence of dark period on the ontogeny of three different selections of johnsongrass.

Procedure

Two experiments were conducted in growth chambers which were identical except for the means in which the continuous dark period was interrupted. Temperature was 35 C for 12 hours and 30 for the remaining 12 hours.

The three selections of johnsongrass were obtained from three locations representing different climates. Plants from a northern cool climate were collected near Hagerstown, Maryland; those from a warm, intermediate region near Princess Anne, Maryland; and those from a warmer, southern region near Stoneville, Mississippi, hereafter referred to as N, NS, and S, respectively. These three selections were vegetatively propagated in the greenhouse. Rhizomes of 3 to 5 nodes from stock greenhouse plants were placed in vermiculite in 15-cm diameter pots, which were transferred to growth chambers for the initiation of both experiments. All pots were watered liberally once a week with a nutrient solution containing four times the concentration as used in Table 1 of Woodman (1939. Ann. Bot. Land ng. 3:649-656). The minor elements were supplied as in Hoagland and Arnon (1950. Calif. Agr. Exp. Sta. Circ. 347:32p). After emergence, half of the original number of pots were discarded while selecting for uniformity.

After shoot emergence, the following data were taken weekly: leaf number, stem number, plant height, and presence or absence of an inflorescence. Root, rhizome, leaf, and stem weights were also recorded at harvest. Both experiments were in progress for 12 weeks from planting of rhizome pieces to harvest. Light intensity was 16,000 Lux produced by cool white fluorescent lamps supplemented with incadescent. Shoots were physically forced to grow decumbent so that flowering could occur. Figure 1 indicates the exact intervals of light and darkness in a 24-hour period for the three treatments in Experiment 1. The number of replications for Experiment 1 varied

among treatments and are presented in Table 1. In Experiment 2, the continuous 12 hour dark period was interrupted daily or only 4 times during the growth period by 2-5 minute intervals of red light equally spaced in the dark period. In Experiment 2 there were 4 replications.

Results

Experiment 1

Certain parameters of growth of johnsongrass were modified by different lengths of darkness. Under a continuous 8 and 16-hour dark period, the S selection grew significantly higher than the other two selections. Under a 12-hour dark period, the three selections had the same relative growth rate until the 7th week of growth after which the N selection initiated a rapid period of growth which made it the tallest selection at the end of the experiment. Response of stem and leaf number was not significantly different among the different dark periods of selections.

At the end of 11 weeks, percent flowering and the dry weights of shoots, roots, and rhizomes were recorded (Table 1). The weight of rhizomes was influenced by both the selection and the dark period. Rhizome growth of the S and NS selections was less under the 8-hour dark period than the 12-hour dark period. Rhizome response to photoperiod was greatest in the NS selection. Rhizome response to photoperiod was greatest in the NS selection. Rhizomes of this selection produced over 10 times as much dry matter at a dark period of 16-hour than at 8-hour. Dry matter accumulation in the roots was different in the three selections, but this was not influenced by the dark period. The shoot dry matter was not influenced by either experimental parameter.

Flowering of the three selections was greatly affected by dark period (Table 1). When the longest dark period was 8 hours, no flowering occurred

in any selection. At 12 and 16-hour dark periods, flowering occurred greatest in the N selection and did not occur at all in the S selection during the time period of this experiment. The NS selection was intermediate in flowering response between the other two selections.

Experiment 2

The results are presented in Table 2 except for the root and shoot weights which were not significantly different. The control figures are also not presented because this growth chamber overheated toward the end of the experimental period. All plants in the control had, however, flowered. This indicates that only four interruptions of the dark period significantly reduced flowering in johnsongrass.

Summary

Two growth chamber experiments were conducted to determine the influence of dark period on growth and flowering of johnsongrass. In the first experiment, it was shown that dark period had an important effect on rhizome growth and flowering. The 12-hour dark period was found to be optimal and the 8-hour dark period completely inhibited flowering during the time period of the experiment. The second experiment confirmed the results of the first and indicated that the response is primarily triggered by the phytochrome system.

Table 1. The influence of dark period on dry matter production and flowering in three johnsongrass selections.

Longest uninterrupted dark period (hr)	Selection	Number of Replications	Mean dry wt. at harvest: Shoot (g)	Rhizome (g)	Root (g)	% Flowering at Harvest
8	N	2	4.6 a[a]	.38 ab	2.02 a	0
8	NS	3	4.6 a	.10 a	3.06 ab	0
8	S	2	5.2 a	.23 a	1.63 b	0
12	N	4	6.2 a	.71 ab	2.45 a	100
12	NS	3	5.4 a	.98 bc	3.06 ab	33
12	S	2	4.0 a	.98 bc	1.45 b	0
16	N	3	5.3 a	.36 ab	1.99 a	67
16	NS	4	4.3 a	1.39 c	2.30 ab	50
16	S	3	4.8 a	.38 ab	1.53 b	0

[a] Within each column, figures followed by different letters are significantly different at the 5% level by Duncan's New Multiple Range Test.

Table 2.

Selection	Constant Interruption: Rhizome weight (g)	Constant Interruption: Flowering (%)	Four Interruptions: Rhizome weight (g)	Four Interruptions: Flowering (%)
N	2.4	25	5.0	80
NS	3.1	0	5.8	20
S	2.0	0	3.9	80

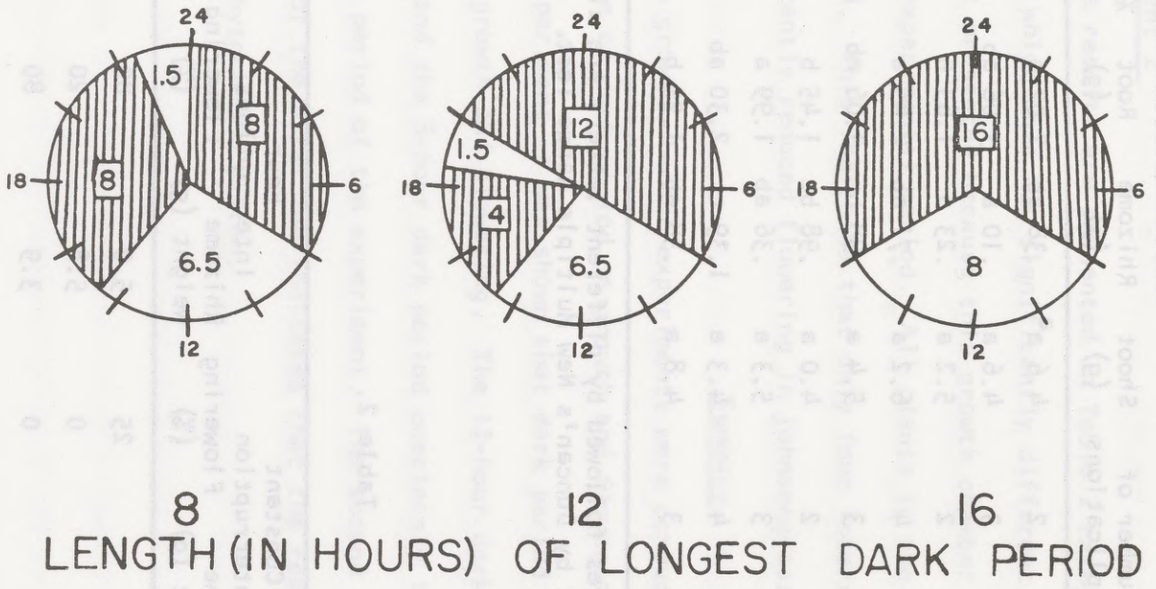

Figure 1. Patterns of day and night periods on a 24-hour cycle used to obtain 8, 12, and 16 hours of continuous darkness with a constant total of 8 hours light.

The Influence of Gibberellic Acid on Three Selections of Johnsongrass

G. W. Burt
Department of Agronomy

Purpose and Objectives

Gibberellic acid has long been known to be one of the most important endogenous growth regulators. It is applied exogenously to initiate flowering, and stem elongation. (Gibberellic acid or antigibberellins have the potential of blocking floral and rhizome initiation.) Different johnsongrass selections have been obtained which differ in their rate of floral initiation and rhizome growth. Differing endogenous concentrations (of gibberellic acid) could be the reason for the differing growth characteristics of these johnsongrass selections. The present experiment was conducted to determine if the different johnsongrass selections would react differently to exogenous applications of gibberellic acid.

Procedure

Three selections of johnsongrass (Sorghum halepense (L.) Pers.) were grown in the greenhouse in a randomized block design with four replications in 15 cm diameter pots. They were sprayed with a total of 30, 0.30, and .0030 mg gibberellic acid (GA) in two equal applications at 3 and 9 weeks after planting rhizome pieces. Plants were harvested 13 weeks after planting and the weight of roots, rhizomes, and stems were recorded. The presence or absence of flowering and the height of all plants was also recorded at 13 weeks. Plants were collected near Hagerstown, Maryland, a northern, cool region (N); Princess Anne, Maryland, a warm, intermediate region (NS); and Stoneville, Mississippi, a warmer, southern region (S).

Results

At 30 mg of GA the weight of the roots, rhizomes, and stems of all selections were approximately $\frac{1}{2}$ of the control. The 0.30 mg GA treatment increased rhizome weight in the N selection but did not affect the rhizome weight in the S and NS selections (Figure 1). Root weight was decreased by the 0.30 mg GA treatment in both the N and NS selections but not in the S selection.

The plant height of the S and NS selections increased with increasing GA concentration. Under the 30 mg GA treatment, however, the N selection had a drastic reduction of height (Figure 2). All concentrations of GA prevented flowering in the S selection (Table 1). In the N and NS selections, only the highest concentration of GA prevented flowering.

Table 1. Percentage of Plants Treated with GA Flowering After 13 Weeks

	GA Applied (mg)			
Selection	0	.003	.3	30
N	100	100	75	0
NS	50	50	50	0
S	50	0	0	0

Summary

Three selections of johnsongrass were grown in the greenhouse and subjected to three concentrations of gibberellic acid. Growth of all three selections of johnsongrass was inhibited at the highest concentration of gibberellic acid. At lower concentrations, the three selections responded differently to the applied gibberellic acid, indicating that the three selections may have differences in the endogenous concentrations of this important growth regulator.

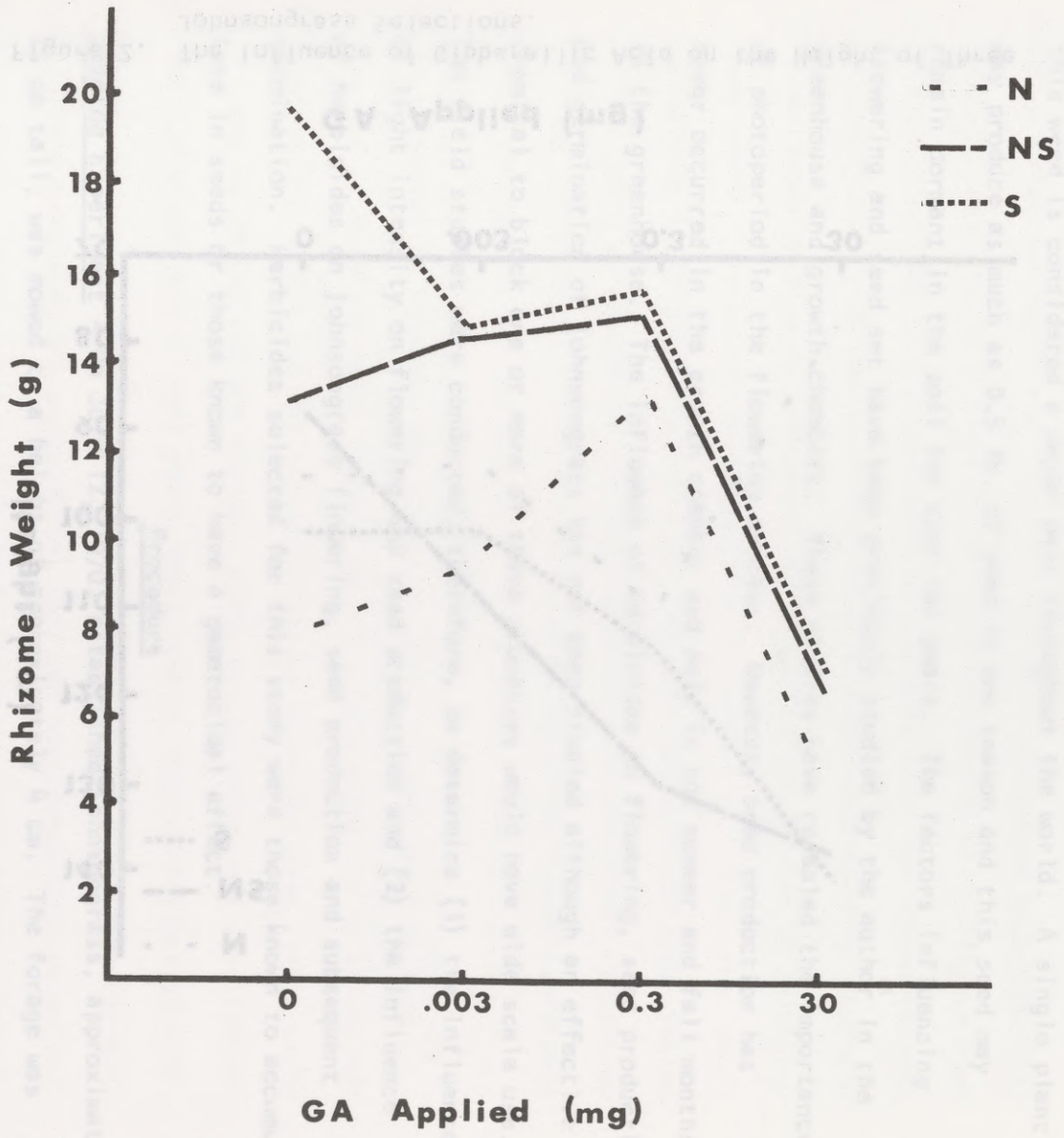

Figure 1. The Influence of Gibberellic Acid on the Rhizome Weight of Three Johnsongrass Selections.

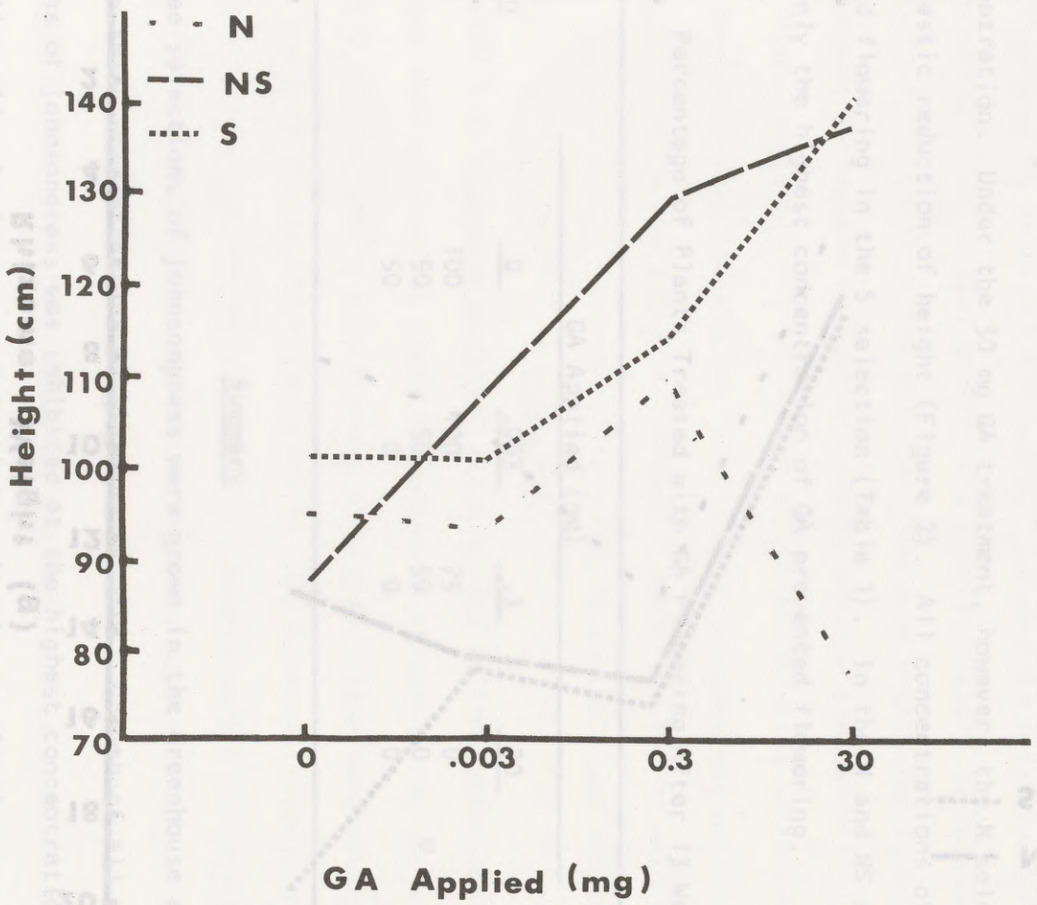

Figure 2. The Influence of Gibberellic Acid on the Height of Three Johnsongrass Selections.

The Influence of Herbicides and Light Intensity on Johnsongrass Seed Production and Germination

G. W. Burt
Department of Agronomy

Purpose and Objective

The prolific seed production of johnsongrass is one major reason why this weed is considered a major pest throughout the world. A single plant may produce as much as 0.5 lb. of seed in one season and this seed may remain dormant in the soil for over ten years. The factors influencing flowering and seed set have been previously studied by the author in the greenhouse and growth chambers. These studies have revealed the importance of photoperiod in the flowering process. However, seed production has never occurred in the growth chamber and only in the summer and fall months in the greenhouse. The influence of herbicides on flowering, seed production and germination of johnsongrass has not been studied although an effective chemical to block one or more of these processes would have wide scale use. Two field studies were conducted, therefore, to determine (1) the influence of light intensity on flowering and seed production and (2) the influence of herbicides on johnsongrass flowering, seed production and subsequent germination. Herbicides selected for this study were those known to accumulate in seeds or those known to have a gametocidal effect.

Procedure

Shading Experiment - On July 12, 1970, established johnsongrass, approximately 25 cm tall, was mowed to a height of approximately 4 cm. The forage was removed from the area and a randomized block design experiment with three

replications was initiated on a Matapeake silt loam. The three treatments were: (a) no shade, (b) shading with tobacco cloth, and (c) shading with a green plastic screening. The plastic screening was estimated to give 80% shading. The frames were 2.13 x 1.83 meters and were adjusted weekly to approximately 15 cm above the top of the tallest johnsongrass stem. On October 17, the plants under the frames (excluding a one foot boarder) were harvested and weighed.

Seed-Herbicide Experiment - On June 5, 1970, herbicides as listed in Table 1 were applied at 30 gallons per acre to the foliage of 30 cm tall established johnsongrass. The experiment was on a Matapeake silt loam in a randomized block design with four replications - plot size was 10' x 30'. Seeds were collected by briskly agitating the inflorescence in a large container. These seeds were then cleaned of debris through forced air. Clean seed weights were recorded and the seeds were stored at 5 C until germination tests were run. Plots were also rated on June 19, and August 6, 1970, for herbicidal damage and stage of maturity.

Results

Shading Experiment - Light intensity was recorded at several times during the course of the experiment. As one example shows in Table 1, the johnsongrass plants were subjected to approximately 20% and 50% of the normal light intensity at the center of the plots. Height and dry weight of the johnsongrass plants were greater under shade than in the controls (Table 2). This was considered to be primarily caused by drought. The most important finding of this experiment was that johnsongrass did produce a small quantity of viable mature seeds under all three shading intensities. It is assumed, therefore, that light quantity is not a critical factor in seed production in johnsongrass.

Seed-herbicide Experiment - Seed weights, percent germination and ratings are presented in Table 3. Dalapon had a greater effect on seed production than any other chemical even though visual damage to johnsongrass was less than for most other chemicals. The organic arsenicals (MSMA and cacodylic acid) gave the greatest injury when observed on June 19; however, these plants quickly recovered and in some cases total seed production was equal to the control. 2,4-D, dicamba and alpha, beta-dichlorobutyrate had little effect on seed production.

Germination of the seeds from the harvest on August 13, (Table 3) showed little effect of all chemicals on germination in H_2O and in KNO_3. Cacodylic acid did, however, increase germination of johnsongrass seeds in H_2O.

Summary

Shading of johnsongrass in the field to 80% of normal sunlight did not prevent flowering and seed set. Dalapon was the most effective chemical in preventing johnsongrass seed production. MSMA and cacodylic acid severely injured johnsongrass in the beginning of the season; however, quick recovery of the johnsongrass allowed seed production to almost equal the control by the end of the season. No herbicide had a large effect on johnsongrass seed dormancy or viability.

Table 1. Light Intensity Under Frames

Mean Foot Candles of Light across plot 4 p.m. 9/23/70 (frames at 61 cm, and recorder at 46 cm above ground)	Distance from side of frame (cm)		Control	Light Shade	Heavy Shade
	(west side)	0	5000	4250	3350
		30	5000	4400	2900
		61	5000	3100	1000
		92	5000	2750	800
		122	5000	2850	1000
		153	5000	2700	1050
		183	5000	2750	1050
	(east side)	214	5000	2650	1300

Table 2. Height and Mean Dry Weight of Johnsongrass Grown Under Shade

	Date	Control	Light Shading	Heavy Shading
Mean Height to Last Ligulate Leaf (cm)*	8/18/70	25	35	60
	10/17/70	37	60	83
Mean Dry Weight (g)	10/17/70	133	261	241

* Uppermost leaf with ligule exposed.

TABLE 3

Influence of Herbicides on Johnsongrass

Herbicide	Rate lb/A	Mean Weight of Seed Harvested at Each Harvest Date					Total for Season	% Germination First Harvest		Visual Injury*
		8/13/70	8/26/70	9/9/70	9/23/70	10/17/70		KNO_3	H_2O	
dalapon	2.5	1.2	0	0	0.6	0	1.8	31	6	5
dalapon	5.0	0	0	0	0	0	0	--	--	6.5
dicamba	0.5	9.3	15.3	9.4	2.0	14.4	50	37	5	0
dicamba	1.0	3.7	7.1	6.5	2.5	---	20	49	8	3
2,4-D	0.5	43.8	30.5	5.8	6.2	12.9	99	37	0	1
2,4-D	1.0	35.2	16.2	2.7	5.0	7.0	66	36	7	0
MSMA	1.5	---	2.7	10.5	12.1	10.1	35	--	--	8.5
MSMA	3.0	0.4	4.6	3.7	21.2	20.3	50	--	--	10
Cacodylic Acid	1.5	8.0	16.2	2.5	9.2	14.3	50.3	34	15	9.5
Cacodylic Acid	3.0	6.6	25.5	---	17.3	29.0	78	36	17	10
2, B-dichloro-butyrate	4.0	32.7	20.3	1.8	5.6	8.0	68	28	8	0
Control	---	48.2	28.8	3.2	5.2	12.8	98	40	5	1.5
Total		169	167	46	87	129				

* 10 = Complete foliage kill; 0 = no injury.

Basipetal Translocation of 2-chloro-4-ethylamino-6-isopropylamino-s-triazine (Atrazine) in Canada Thistle

G. W. Burt
Department of Agronomy

Purpose and Objective

Atrazine is usually more effective in controlling Canada thistle as a postemergent than as a preemergent application. The increased effectiveness of the postemergent application could be associated with the growth characteristics of Canada thistle or with the basipetal transport of atrazine. Atrazine is known to translocate acropetally in several species (Crafts, Alden S. and Shogo Yamaguchi. 1964. Manual 35. Calif. Agr. Exp. Station). This study was conducted to determine if atrazine could be translocated basipetally in Canada thistle. Application of atrazine to shoots could cause the production of toxic compounds which, if translocated to the roots, would cause death. This possibility of an indirect effect of foliar atrazine on the roots was also studied in greenhouse experiments.

Procedure

Plant Culture and Herbicide Application

Canada thistle were grown in 15 cm diameter pots in the greenhouse with the day length extended to 15 hours photoperiod by incadescent lighting. Plants were grown in vermiculite and watered bi-weekly with nutrient solution containing 4 times the concentration as used in Table 1 of Woodman (Woodman, R. M. 1939. Ann. Bot. Land. ns. 3:649-656). The minor elements were supplied as in Hoagland and Arnon (1950. Calif. Agr. Exp. Sta. Circ. 347: 1-32). A preliminary experiment indicated that 900 µg per plant caused a high degree of chlorosis without death. These experiments also indicated a physiological response of atrazine on the roots of Canada thistle. Therefore, this rate was used in all experiments. The atrazine was applied in solution by brushing the herbicide solution on one elongated stem.

The stem was wrapped at its base with paper toweling to prevent the solution from entering the surface of the vermiculite. Two milliliters of solution were used which was sufficient for adequate coverage of all above ground plant parts.

Studies with ^{14}C-atrazine

Plants were treated in the laboratory with 900 µg atrazine containing 0.2 µc ring-labeled ^{14}C atrazine and placed in a growth chamber at 35 C day temperature, 30 C night temperature, and with a photoperiod of 12 hours with 3000 foot candles light intensity. After 4 days, the plants were removed from the growth chamber, the tops excised from the roots, and either (1) freeze dried for use in autoradiography, or (2) extracted and ^{14}C counted by scintillation techniques.

1. Autoradiography: The plants were placed in a container of dry ice and freeze dried in an Amsco L-3 freeze drier. The dried plants were subsequently remoistened, mounted on paper and placed next to Kodax blue screen X-ray film for 4 weeks after which the film was developed by standard procedure.

2. Extraction Procedure: Atrazine ^{14}C-treated tissues were ground in an omni mixer in 80% methanol and filtered. The resulting filtrate was dried under vacuum and the resulting residue taken up in 50 ml H_2O and partitioned with 50 ml chloroform. One milliliter of these solutions were counted for radioactivity on a Nuclear Chicago Unilux Scintillation counter using the channels ratio method. The remaining filtrate was further purified and run on thin layer chromatograms as previously described (Shimabukuro, R. H. 1967. Plant Physiol. 42:1269-1276; Shimabukuro, R. H. 1967. J. Agr. Food Chem. 15:557-562; Shimabukuro, R. H., R. E. Kadunce, and D. S. Frear. 1966. J. Agr. Food Chem. 14:392-395). These

chromatograms were placed next to X-ray film to determine the position of radioactive areas.

Greenhouse Studies

Eight plants were selected which contained one elongated stem and one recently emerged stem. Atrazine at a dose of 900 µg/stem was applied to the elongated stem of 4 plants. The remaining 4 plants were used as controls. Height and leaf number of the recently emerged stem as well as the production of new stems were used as an indicator of any effects of atrazine which might be transferred basipetally. The elongated stems on the control plants were excised on the day of treatment.

Results

^{14}C-atrazine studies -

Autoradiography of Canada thistle plants revealed no significant basipetal movement of ^{14}C atrazine within 3 days after foliar application. Little radioactivity was detected in the roots, and the foliar applied atrazine appeared to have moved almost entirely acropetally, accumulating primarily in the leaf margins.

Radioactivity in the water and chloroform fractions (1/50 of total) are presented in Table 1 for both roots and shoots.

Table 1. dpm in Extracts of Canada thistle

Extracts	Shoots	Roots
Chloroform	750	11
Water	127	4

The purified extract of the shoot fraction was chromatographed and the resulting autoradiogram indicated that most radioactivity was still in the form of the unaltered atrazine molecule.

Greenhouse Experiments

Growth of the recently emerged stem on a plant whose elongated stem was treated with atrazine was measured and the data is presented in Table II. Twelve days after atrazine application, there was a significant decrease in the number of stems caused by atrazine application. At 19 days after treatment, both the number of leaves and the number of stems were significantly greater in the controls than in the treated plants at the 5% level. The increase in the number of stems in the control compared to treated plants was attributed to the cutting off of the elongated stem in control but not in treated plants on the date of treatment. This could have initiated new stem production. These data, therefore, present very little indication of basipetal movement of any toxic compounds caused by atrazine application.

Table 2. Growth of an Emerging Canada Thistle Shoot after Atrazine Treatment To an Elongated Shoot on the Same Plant. Figures in a column followed by the same letter are not significantly different at the 5% level of significance.

	12 Days After Treatment		
	Increase in Height (cm)	Increase in Number of Leaves	Number of New Stems Produced
Treated Plants	7.0 a	3.2 a	2 a
Control Plants	7.0 a	4.0 a	4 b

	19 Days After Treatment		
	Increase in Height (cm)	Increase in Number of Leaves	Number of New Stems Produced
Treated Plants	9.0 a	6.0 a	2.2 a
Control Plants	9.2 a	7.2 b	4.2 b

Summary

The elongated stem of several Canada thistle plants containing one elongated and one recently emerged stem was treated with 900 µg atrazine. Subsequent growth indicated little or no basipetal translocation of atrazine. Antoradiographic results with ^{14}C-atrazine also supported the hypothesis that little or no basipetal translocation of atrazine occurred. The metabolism of atrazine was found to be extremely slow in Canada thistle which suggests a primary reason for its susceptibility. The above results suggest that a postemergent application of atrazine to Canada thistle is of no advantage over a preemergent application with regard to translocation of atrazine into the rhizomes.

Control of Johnsongrass With Toluidines And Related Compounds

G. W. Burt
Department of Agronomy

Purpose and Objective

Recent work has indicated that toluidines at higher than normal rates will effectively control johnsongrass if used successively for three or more years (McWhorter. 1970. Weed Sci. Soc. Amer. Abstracts p. 43). McWhorter's research has shown that trifluralin is especially effective and this work has been instrumental in causing me to plan similar work in the field. The question arises however, are some of the many new toluidines more effective than trifluralin? The tetrazolium assay, developed by G. W. Burt, is an excellent and quick technique which is used to determine herbicide toxicity. In the present study this assay was used to determine the relative activity of toluidines on johnsongrass rhizome tissue.

Procedure

Johnsongrass was vegetatively propagated and grown in vermiculite in the greenhouse until rhizomes formed. Flats were watered biweekly with nutrient solution containing four times the concentrations as used in Table L of Woodman (Woodman, R. M. 1939. Ann. Bot. Land. ns. 3:649-667). Nitrogen was supplied at 100 ppm as $NaNO_3$. The micro elements were supplied as in Hoagland and Arnon (Hoagland, D. R. and D. I. Arnon. 1950. Calif. Agr. Exp. Sta. Circ. 347:1-32).

For the initiation of each run, sufficient rhizome material was harvested from the flats and cleaned. The internodes were cross sectionally cut into one or more 2 to 3 mm thick disks to total approximately 100 mg of tissue. The weight of this tissue was recorded and the tissue was

immediately placed into 120 x 10 mm test tubes containing 3 ml solution of the appropriate concentration of herbicide in addition to a KH_2PO_4-Na_2HPO_4 buffer at pH 6.5. The tissue remained in the solution for 24 hours at room temperature under constant agitation and then was transferred to 3 ml of a 0.6% solution of 2,3,5-triphenyl-2H-tetrazolium chloride in KH_2PO_4-Na_2HPO_4 buffer at pH 6.5. The tissue was incubated in this solution for 24 hours at 30 C, ground one minute in an Omni-mixer with 10 ml 95% ethanol, filtered through a Whatman No. 1 filter paper, and the optical density (OD) at 530 mu was recorded. Each chemical was analyzed for at least six concentrations after preliminary results indicated the approximate concentration range for each chemical. Each run for each chemical had five replications and was repeated three times, therefore there was a total of 15 replications per chemical per concentration. Data were calculated on a percentage of the control per 100 mg tissue. Linear regression was performed on all data. Differences between regressions were determined as in equation 9.18 (Steel & Torrie, 1960. McGraw-Hill Book Co.).

Chemicals used were: alpha, alpha, alpha-trifluoro-2,6-dinitro-N, N-dipropyl-p-toluidine (trifluralin); N-butyl-N-ethyl-alpha, alpha, alpha-trifluoro-2,6-dinitro-p-toluidine (benefin); 4-(methylsulfonyl)-2,6-dinitro-N, N-dipropylaniline (nitralin); N-secondary-butyl-4-tertiary-butyl-2,6-dinitroaniline (A-820); 4-chloro-5-(methylamino)-2-(alpha, alpha, alpha-trifluoro-m-tolyl)-3(2H)-pyridazinone (San 9789); N^3, N^3-diethyl 2,4-dinitro-6-trifluoromethyl-1,3-phenylenediamine (USB 3584).

Results

Figure 1 shows the regression lines for all six chemicals studied. Statistical analysis indicated that the slope of the trifluralin and the A-820 were identical. The standard deviations of the means were less than 15%; thus the trifluralin and the A-820 lines were statistically different

at the 5% level of significance.

The results indicate that USB 3584, and benefin have greater activity than trifluralin in johnsongrass rhizomes. Nitralin, as expected from field work, was slightly less active than trifluralin and A-820 reacted similarly to nitralin. San 9789 was very ineffective in this study.

Summary

Six chemicals potentially useful for johnsongrass rhizome control were evaluated by the tetrazolium assay. Results indicated that several of these chemicals have activity greater or equal to trifluralin and, therefore, warrant further testing in the field.

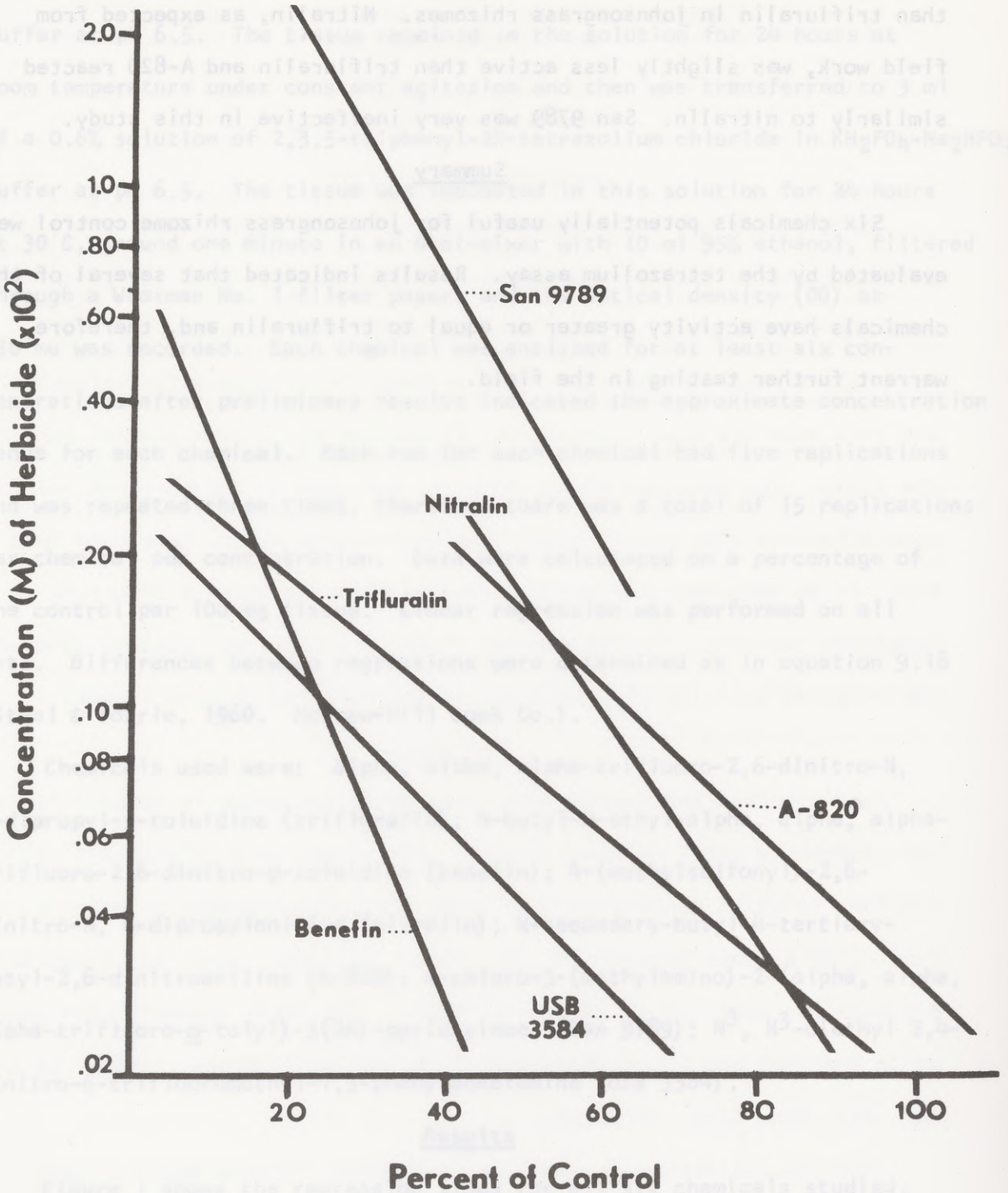

Figure 1. Influence of Toluidine Herbicides on Tetrazolium Reduction in Johnsongrass

Breeding and Evaluating Full Season Soybean Genotypes

B. E. Caldwell
Department of Agronomy, and Soybean Investigations,
Crops Research Division, U. S. Department of Agriculture,
Beltsville, Maryland

Purpose and Objectives

To obtain soybean varieties, adapted to the Mid-Atlantic states, which are superior to those varieties presently being grown in this area.

Procedures

Breeding procedures used in the program are standard bulk and pedigree systems. Crosses are made and populations are maintained in bulk until the F_3 or F_4. Selections are made and evaluated in yield tests. Superior lines are advanced for more extensive testing. The Mid-Atlantic tests are the most advanced local tests. Lines surviving these tests are advanced to the Uniform Preliminary Test and finally to the Uniform Test.

Results

Excellent results were obtained at Linkwood, but a lack of adequate rainfall at Queenstown reduced yields, especially for the IVS and V maturity lines.

The only entry, Md62-3223, in the Uniform Group IV test was not superior to Cutler. At Linkwood it was 5.3 bushels less than Cutler, consequently this line will not be tested further.

Four lines were entered in Uniform Preliminary IV. One of these, Md62-1258, performed well and was advanced to the Uniform Tests for evaluation in 1971. (Table 1) Md62-3303 also performed well. Md63-3303-3, a selection from Md62-3303, was substituted for Md62-3303 in the 1971 Uniform Test.

Twelve lines were entered in Uniform Preliminary IVS. Two of these, Md66-1058 and Md66-1311 performed sufficiently well to be advanced to Uniform Test IVS for 1971. (Table 1)

Several of the lines that performed well but were not advanced to Uniform Test were entered in the Mid-Atlantic Test IVS. In this test, they will be evaluated for specific adaptability to the Mid-Atlantic area.

In Table 3, data is presented for Maryland lines that were grown in the Mid-Atlantic tests. In MA IV, only one line, Md63-3303-3 exceeded Cutler in yield at Linkwood. However, several lines were retained for further evaluation. In MA IVS, a number of lines were superior to Kent. These will be re-evaluated in 1971. Md63-3303-3 has been evaluated since 1967. Performance for this line is given in Table 2. Based on its continued superior performance, it should be released.

Blend studies begun in 1969 failed to show a superiority of blends over their pure line components. Competition studies in hill plots were continued in an effort to determine optimum frequencies for several varieties. This is a long term study, and data should be available after 1971.

Summary

A number of soybean genotypes were evaluated. Based on the 1970 tests, several lines show promise as varieties for the Mid-Atlantic area. One, Md63-3303-3 is recommended for release.

Table 1. Performance of Maryland lines in Uniform Preliminary Test IV and IVS. 1970.

	Yield					
	Mean 9 loc UPG	Queenstown	Linkwood	Linkwood Protein	Linkwood Oil	Linkwood Maturity 1/
Uniform Preliminary Test IV						
Cutler	52.3	34.4	48.7	40.8	21.9	19
Kent	49.2	29.5	42.2	40.7	22.2	25
Md62-3303	50.3	39.8	50.9	39.7	23.2	19
Md66-1041	44.3	33.8	41.8	40.2	22.3	21
Md66-1258	54.0	37.0	48.7	40.6	21.7	10
-1337	48.1	33.8	44.2	40.1	22.7	22
Uniform Preliminary Test IVS						
Kent	33.9		45.1	40.7	23.3	22
Custer	32.5		42.8	37.4	23.8	25
Md62-2138-2	32.5		41.4	42.0	22.8	22
Md62-2939	35.9		41.9	40.8	24.2	25
-3505	37.3		47.8	38.4	25.2	27
Md65-3806	31.5		42.4	41.1	22.4	18
Md66-1026	33.5		38.9	42.0	21.9	22
Md66-1049	34.7		43.9	39.7	22.3	23
-1058	38.2		50.0	39.9	23.8	22
-1155	36.5		46.3	40.5	22.9	24
-1207	33.9		47.9	41.0	22.8	25
-1219	34.6		45.6	41.7	22.1	25
-1311	35.7		45.8	40.3	23.8	28
-1312	34.0		43.8	38.6	23.1	30

1/ Days from September 1

Table 2. Maryland line of maturity group IV being considered for release.

	1966[a]	1967[b]	1968[c]	1969[d]	1970[e]	66-70 $\bar{X}$ Yield	67-70 % Protein	Oil
Md63-3303-3	37.0	38.2	48.7	45.5	41.2	42.1	43.4	40.6	23.5
Clark	31.6	25.3	45.9	40.4	36.6	36.0	37.0	41.1	22.6
Cutler	-	40.0	48.5	45.8	37.7	-	43.0	42.2	22.0

[a]one location; [b]two locations; [c]three locations; [d]five locations; [e]nine locations.

Table 3. Performance of Maryland lines in Mid-Atlantic Test IV and IVS. 1970

	Yield			Linkwood		
	Queenstown	Linkwood	Linkwood Queenstown $\bar{X}$	Protein	Oil	Maturity 1/
Mid-Atlantic Test IV						
Clark	28.3	44.2	36.2	39.3	23.6	19
Cutler	27.1	48.0	37.6	40.2	23.4	19
Md62-3303	27.1	41.6	34.4	38.2	25.2	19
-3605	26.9	37.5	32.3	37.1	25.8	20
Md63-3303-3	30.0	48.4	39.2	37.8	25.0	22
Md65-3806	27.9	45.7	36.8	40.0	22.9	22
Md66-1024	31.4	45.1	38.2	38.1	24.5	24
-1042	30.8	41.9	36.4	39.7	23.4	22
-1105	31.3	40.4	35.8	38.3	23.7	20
-1109	31.5	43.7	37.6	39.3	23.6	20
-1129	27.7	42.1	34.9	39.0	24.0	23
Md69-100B	29.7	38.1	33.9	39.0	24.3	27
Mid-Atlantic Test IVS						
Kent	36.3	38.5	37.4	39.9	23.7	24
Delmar	23.6	42.4	33.0	38.7	24.0	28
Md62-3514	38.9	44.4	41.6	38.3	23.6	27
-3514-4	34.6	43.0	38.8	41.2	23.2	22
-3514-10	29.4	43.3	36.4	40.9	24.0	27
Md66-1021	27.5	34.6	31.0	38.7	24.0	32
-1056	35.6	39.6	37.6	38.6	23.4	28
-1057	32.8	39.6	36.2	38.4	23.4	28
-1218	28.2	42.2	35.2	38.9	24.7	25
-1321	32.5	40.5	36.5	38.8	25.0	38
-1326	22.5	40.8	31.6	39.9	23.4	35
-1327	33.5	44.7	39.1	39.4	23.9	38
-1344	30.9	43.0	37.0	39.9	24.5	20

1/ Days from September 1

The Response of Field Crops to Fertility and Irrigation

N. A. Clark
Department of Agronomy

Purpose and Objectives

This study compares corn, barley and soybeans under three fertility levels, and with overhead irrigation, subirrigation, and no irrigation. Subirrigation, with perforated plastic pipe, is a recent development and it is possible that water use by the system might differ from that of overhead systems due to differences in evaporation and water movement into the subsoil. Objectives of the study were to compare irrigation systems and the efficiency of fertilizer use under the three irrigation regimes.

Procedures

The experiment was a split plot design with irrigation regimes as whole plots. Crops and fertility treatments were assigned at random as subplots within each whole plot. There were three replications. The crops were: corn grain (fallow), corn silage (fallow), corn silage-barley silage (double crop), soybeans-barley grain (double crop). Fertilizer treatments were: $\frac{1}{2}$ soil test, soil test, and double soil test recommendation. Overhead irrigation was by a Skinner sprinkler system and subirrigation was by means of a $\frac{1}{2}$-inch plastic pipe with a 0.03-inch holes at one-foot intervals along the pipe. The pipe was buried one foot deep, and the pipes were spaced every three feet the length of the whole plot. Pressure was maintained at three pounds by a tank with a leveling float at the head of each subirrigation plot.

Planting and harvest dates are shown in Table 1, and fertilizer treatments are in Table 3.

Results

Rainfall and irrigation are shown in Table 2 and yields in Table 4. Rainfall was abundant from April through July and little additional irrigation water was needed. However, to insure that adequate moisture would be available, approximately 3/4-inch was applied as sub-irrigation and overhead irrigation in both June and July. Natural rainfall in August was only 2.2 inches, so over 2-inches additional irrigation water was added in both systems.

All crops (Table 4), with the exception of soybeans, showed a yield response to the medium and high rates of fertilizer, but not to irrigation. No significant yield differences were found with soybeans regardless of irrigation or fertilizer treatment. These results are contrary to results obtained in previous years, where irrigation has been found to increase yields substantially. This is an indication that natural rainfall was adequate for the 1970 growing season.

Summary

Corn, barley and soybeans were compared under three fertility levels; and with overhead irrigation, sub-surface irrigation, and no irrigation. Rainfall was abundant during the growing season, except in August. Therefore, less than 1-inch of irrigation water was applied in June and July, but over 2-inches was applied in August. All crops, except soybeans, showed a response to medium and high levels of fertilizer. Soybeans did not show a yield increase due to fertilizers. None of the crops showed a yield increase with irrigation, indicating that natural rainfall was adequate for crop growth.

Table 1. Planting and Harvest Schedules for 1970.

Crops	Planting Date	Harvest Date
Barley (silage) Wong	9/17/69	5/21/70
Barley (grain) Barsoy	9/17/69	6/19/70
Corn (grain) Pioneer 3306	5/11/70	10/06/70
Corn (silage-fallow) Pioneer 3306	5/11/70	9/09/70
Corn (silage-double crop) DeKalb XL45	6/02/70	9/18-21-22/70
Soybeans - Calland	6/22/70	11/05/70

Table 2. Rainfall and Irrigation for 1970.

Month	Rainfall* (inches)	Irrigation applied (inches)	
		Overhead	Subirrigation
April	4.84	- -	- -
May	3.50	- -	- -
June	3.96	0.70	0.80
July	7.03	0.70	0.80
August	2.20	2.80	2.40
September	1.19	- -	- -

* Recorded at Clarksville 3N.

Table 3. Fertilizer Application for 1970.

Crop	Fertility Level	Fertilizer Applied			How Applied
		N	P_2O_5	K_2O	
Barley (silage)	Low	25	100	100	- - - - -
	Medium	50	200	200	- - - - -
	High	100	400	400	- - - - -
Barley (grain)	Low	2.5	100	100	Plow down
		12.5	- -	- -	Top dress
	Medium	50	200	200	Plow down
		25	- -	- -	Top dress
	High	100	400	400	Plow down
		50	- -	- -	Top dress
Corn (grain)	Low	45	20	20	Plow down
		10	10	10	Planter
	Medium	90	40	40	Plow down
		20	20	20	Planter
	High	180	80	80	Plow down
		40	40	40	Planter
Corn (silage-fallow & double crop)	Low	66	30	30	Plow down
		3.7	7.5	11.2	Planter
	Medium	132	60	60	Plow down
		7.5	15	22.4	Planter
	High	264	120	120	Plow down
		15	30	45	Planter
Soybeans	Low	0	100	100	- - - - -
	Medium	0	200	200	- - - - -
	High	0	400	400	- - - - -

Table 4. Yields of Corn Grain, Corn Silage (fallow), Barley Silage, Corn Silage (double crop), Barley Grain, and Soybeans - 1970.

Irrigation Regime	Fertility Level	Corn Grain (fallow)	Corn Silage (fallow)	Barley Silage (double crop)	Corn Silage (double crop)	Barley Grain (double crop)	Soybeans (double crop)
		Bu/A	T/A DM	T/A DM	T/A DM	Bu/A	Bu/A
No	Low	114	7.4	1.0	5.9	26	31
Irrigation	Medium	116	7.3	1.8	6.5	40	35
	High	134	7.7	2.9	6.1	84	35
Sub-	Low	107	7.8	1.1	5.9	33	37
Irrigation	Medium	123	8.9	1.7	6.2	63	36
	High	134	8.1	2.4	6.6	69	34
Overhead	Low	107	8.1	1.0	5.1	31	41
Irrigation	Medium	135	8.3	1.8	6.7	45	44
	High	140	9.1	3.0	7.1	70	37

Effects of Variety, Selection, and Production Methods of Corn on the Feeding Value of Corn Silage

N. A. Clark and B. A. Schneider
Department of Agronomy

Purpose and Objectives

The overall objectives of this study are to determine the effects of genetically controlled morphology, planting rate, soil nutrient relationships, and time of harvest on the following components of silage corn:

1. yield
2. ear-stalk ration
3. TDN
4. ripening characteristics
5. protein content
6. nitrate nitrogen
7. fiber and lignin percentage
8. mineral content

This research was conducted in cooperation with the Department of Dairy Science. Feeds low in potassium presently interests dairy nutritionists. Our immediate objective was to produce corn silage with wide ranges of K, and also the study the effect of K balance on nitrate nitrogen, lignin, and mineral content in the plant tissue.

Procedures

The experiment was set up as a randomized complete block with four replications. Each plot consisted of four 30-inch rows, 30 feet in length. The fertility treatments were randomized in each replication and arranged as shown in the following incomplete factorial:

1. Check
2. N
3. K
4. Mg

5. Ca

6. N + K

7. N + Mg

8. K + Mg

9. K + Ca

10. N + K + Mg

Nitrogen was applied at 300 lbs/A, as ammonium nitrate; K at 300 lbs/A, as muriate of potash; Mg at 300 lbs/A, as Epsom salts; and CaO at 2000 lbs/A, as ground agricultural limestone all of which passed a 20 mesh screen and 60% which passed a 100 mesh screen. Phosphorous was uniformly applied over the entire plot from superphosphate at a rate of 130 lbs/A.

All the materials were applied with a Gandy spreader and then disked into the soil. The corn was planted on May 22nd using the variety Pioneer 3306. Immediately after planting, the entire area was sprayed with 4 lbs/A of atrazine.

Plant samples were taken at random from each plot at the full silk stage and at the silage stage (45% DM). The plants were divided into stalks and leaves, and also at the last sampling the cobs and kernels were also collected separately.

All mineral and cell wall components were completed for all the samples and statistically analyzed.

Results

Corn yields are reported in Table 1. All treatments with N had significantly higher whole plant and grain yields. Potassium plots also had high yields. The N + K + Mg had the highest grain yields of all the treatments.

Both K and N percentages were highest in treatments receiving these cations (Table 2). Nitrogen levels were reduced by all single cation treatments except N. Cell walls were lowest under the N, Mg, N + K, and N + K + Mg treatments. The acid-detergent fibers were high under all K treatments except the N + K + Mg. Generally treatments receiving K were highest in digestible dry matter.

Summary

Corn was grown under various combinations of N, K, Mg, and Ca. Both N + K and N + K + Mg had the highest whole plant silage and grain yields. Magnesium, alone, had the lowest yields. Corn at silage stage on both N or K plots were generally the highest quality.

Table 1. Corn Silage Harvest Yields [1/].

Treatment	30% DM Silage		
	Whole Plant	Stover	Grain Yield
	T/A	T/A	bu/A
Check	23.5 c*	13.3 b	115 cde
N	29.6 a	11.5 c	167 ab
K	29.2 a	14.3 a	112 de
Mg	22.6 c	15.2 a	102 e
Ca	23.5 c	13.1 b	136 bcd
N + K	31.4 a	13.4 b	159 abc
N + Mg	29.7 a	13.0 b	171 ab
K + Mg	21.8 c	12.3 bc	146 bcd
K + Ca	27.7 b	15.8 a	134 b-e
N + K + Mg	30.3 a	13.5 b	192 a

[1/] Variety Pioneer 3306, population 28,000.

* Means with the same letter within a column are not significantly at the 5% level.

Table 2. Potassium, N, cell walls, acid-detergent fiber (ADF), lignin, and estimated digestible dry matter (DDM) percents for corn whole plant samples at the silage stage.

Treatment	K	N	Cell Walls	ADF	Lignin	Est. DDM
	%	%	%	%	%	%
Check	0.9 c[1/]	1.1 cd	62.5 ab	31.1 ab	5.2 a	63.4 c
N	0.8 c	1.5 a	57.9 de	32.0 ab	4.7 a	68.5 ab
K	1.6 a	1.0 d	62.2 a-d	33.3 a	4.6 a	71.3 a
Mg	0.8 c	1.2 bc	58.2 cde	30.0 b	4.5 a	66.1 bc
Ca	1.0 bc	1.1 cd	60.2 b-e	31.4 ab	5.2 a	64.1 bc
N + K	1.7 a	1.5 a	57.7 e	32.1 ab	5.1 a	66.6 bc
N + Mg	0.7 c	1.6 a	62.4 abc	29.2 b	4.8 a	63.6 c
K + Mg	1.6 a	0.8 d	62.3 a-d	34.6 a	5.4 a	65.3 bc
K + Ca	1.6 a	1.1 cd	65.1 a	35.4 a	5.4 a	65.2 bc
N + K + Mg	1.4 ab	1.3 abc	58.8 b-e	29.1 b	4.5 a	65.2 bc
C. V. %	20.9	15.6	4.4	8.9	12.6	4.3

1/ Means with the same letter within a column are not significantly different at the 5% level.

Harvest Management of Crownvetch-tall fescue Mixtures

A. M. Decker
Department of Agronomy

Purpose and Objectives

Crownvetch has long been recognized as an excellent species for ground cover and bank stabilization. Because of its wide adaptibility to soil and climatic conditions, considerable interest has been generated in recent years in utilizing this species as a forage in the livestock industry.

Early work at Maryland and other states suggest that crownvetch could best be utilized as a forage when grown with a grass. With this in mind, stands of crownvetch and Ky-31 tall fescue were established. The objectives of the study were to measure total forage production and seasonal distribution of that forage as influenced by harvest frequency and stubble height. A third objective was to study the effects of harvest management on persistence of crownvetch.

Procedures

Penngift and Chemung crownvetch were seeded in randomly selected plots in each of four replications of the study. Ky-30 tall fescue was uniformly seeded in all plots and all borders. The experimental area was uniformly harvested during 1969 in order to establish uniform mixture of grass and legume. Harvest treatments were started in the spring of 1970. The design of experiment was a split plot with four replications. Crownvetch varieties were whole plots, harvest frequency

(3, 4, 5 cuts) were sub-plots, and stubble height (1.5, 2.5, 3.5 inches) were sub-sub-plots.

Data were collected on total forage yields, seasonal distribution of that forage, and persistence of the crownvetch varieties.

Results

Forage yields obtained during the first year of the study (1970) are given in Table 1. Because of extended drought toward the end of the growing season minimal growth occured and the scheduled number of harvests were not made. The 3 and 4 harvest schedules were cut only twice and the 5-harvest schedule was cut only three times. As a result, yields were low and not representative of a "normal" season with all harvests being made.

Penngift was more productive than Chemung. This was true regardless of the harvest frequency or stubble height. Yields were generally higher at the lower stubble heights and when harvested less frequently. Percent yield increase, resulting from low stubble height, was greater when harvested less frequently. However, the amount of crownvetch present at the end of the 1970 growing season was greater at the higher stubble heights and on the more frequently harvest plots. It will take at least one more season to determine the true relationship between harvest management, forage yields and stand persistence. This is especially true because of the short growing season caused by the drought.

Summary

1. Forage yields were highest with Penngift.
2. Penngift was more persistent than Chemung.
3. Forage Yields tended to increase with lower stubble heights and decrease with more frequent harvesting.
4. Stand persistence appeared to be higher with high stubble harvest.

Table 1. Dry matter yields of Crownvetch and Ky-31 tall fescue mixtures as affected by harvest frequency and stubble height.

Treatment			Varieties		
Harvests		Stubble Height	Penngift	Chemung	Average
No.		in.	T/A	T/A	T/A
5	(3)[1/]	1.5	2.86	2.04	2.45
		2.5	2.51	1.59	1.87
		3.5	2.34	1.68	2.01
		Av.	2.59	1.77	2.17
4	(2)	1.5	2.24	1.78	2.01
		2.5	2.21	1.74	1.98
		3.5	1.77	1.39	1.58
		Av.	2.07	1.64	1.86
3	(2)	1.5	3.36	2.53	2.94
		2.5	2.91	2.38	2.64
		3.5	3.00	2.20	2.60
		Av.	2.09	2.37	2.73
Average:		1.5	2.82	2.12	2.47
		2.5	2.54	1.91	2.22
		3.5	2.37	1.76	2.06
		Av.	2.58	1.93	

[1/] Actual number of harvests made in 1970.

Midland Bermudagrass Flaming Studies

A. M. Decker and W. L. Harris
Departments of Agronomy and
Agricultural Engineering

Purpose and Objectives

Winter annual weeds are usually a problem with early harvests of Midland bermudagrass. When infestations are severe, growth initiation of the bermuda is retarded, forage quality is reduced, and weeds rob the crop of early spring moisture. These weeds can be reduced by fall sod-seeded cereals. In addition to controlling these weeds, seasonal forage yields are increased with the sod-seeded cereals (Maryland Bulletin 484, 1969).

Research with Coastal bermuda has shown that winter annual weed can also be reduced by the burning of dormant stubble. These studies showed increased forage yields and more effecient nitrogen utilization when the source was Urea.

The objectives of this research were to test the effects of controlled flaming on (A) winter annual weeds in Midland bermudagrass stands, (B) forage yields, (C) forage quality, as measured by percent protein, and (D) effeciency of nitrogen fertilization applied as NH_4NO_3 or urea.

Procedures

Two experiments were conducted on a 5-year old Midland stand growing on a Monmouth, loamy, fine sand with a pH of 6.2 and a medium to high level of P and K. The area was uniformly fertilized with 645 lbs/A of a 0-15-30 fertilizer.

Experiment 1:

The field plot design was a randomized split plot with six replications. The whole plots were 20 by 25 feet and consisted of sod-seeding, early flame, late flame, check. The sub-plots were nitrogen fertilizer rates of 200, 400 and 800 lbs. N/A in four equal split applications. The source of nitrogen was NH_4NO_3.

Cereal rye was seeded October 27th, 1969. The early flaming was done on March 3rd, 1970 when the bermuda was still dormant, and the late flaming on April 27th, just as green shoots started to appear on the bermuda.

The sod-seeded rye was harvested on May 1st and all plots received one fourth of the total nitrogen to be applied. The same amount of nitrogen was applied after each of the next three harvests (May 26th, July 7th, and August 6th). The final harvest for all treatments was made on September 18th. Representative samples (approx. 2 Kg) were collected from each plot and taken to the laboratory for botanical composition determination. Samples were then dried, ground, and used for nitrogen determinations. It was necessary to make separations only on the May and July harvests since the May 1st harvest of the sod-seeded treatments and the August and September harvests of all treatments were essentially weed-free. Yields are reported in tons of dry matter per acre.

Experiment 2:

The whole plots were flamed vs. unflamed. Six sub-plots (200, 400 and 800 lbs. N/A applied as NH_4NO_3 and urea) were completely randomized

within each whole plot. The nitrogen fertilizer was weighed for each subplot and spread by hand to assure equal and uniform nitrogen applications.

The first nitrogen application was made on May 4th and 5th with the remainder being applied in equal amounts after each of the next three harvests (June 1st, July 6th, and August 10th). The same harvest procedure was followed as in experiment 1. The final harvest for both studies was made on September 18th.

Results

Because of space limitation, only a small part of the data will be presented and discussed. Percent weeds in the first two harvests, total forage yields, and percent nitrogen in the harvested forage from experiment one, will be used to illustrate treatment responses (Table 1). Since two sources of nitrogen were used in experiment two, nitrogen recovery data will be presented only from this study (Table 2).

The results from these two experiments will then be discussed in general terms. Data from this first year indicate that flaming bermudagrass stands can significantly decrease the amount of winter annual weed infestation. To be most effective, however, this flaming should not be done too early. It appears that flaming just as the bermuda starts to grow is near ideal. Most of the winter annual weeds will be killed at this time and the rapidly growing bermuda covers the denuded soil to prevent the growth of later germinating weeds. Flaming too far in advance of this date encourages weed germination and growth but does not stimulate early growth initiation of the bermuda. Indications are that too early

flaming may actually increase the weed problem, especially spring germinating weeds.

The degree of weed control obtained with the late flaming (just as the bermuda started to send up green shoots) were good but was not as complete as with fall sod-seeded cereal rye. The sod-seeded cereal also increased total forage production per acre.

Nitrogen recovery was 5% higher for urea than for NH_4NO_3. This was the reverse of earlier research at Maryland and other stations. On the flamed plots urea had an additional 5% advantage over NH_4NO_3. This too was the reverse of earlier research. The unflamed treatments actually removed a higher percentage of applied nitrogen. This increase was largely due to the heavy weed growth of the first two harvests.

It would appear from these studies to date that flaming may have a place in the production of bermudagrass forage where it is important to eliminate the winter annual weeds from the early harvest but where it is not feasible or desirable to use a fall sod-seeded crop for this purpose. It seems reasonable that periodic flaming of bermudagrass stands could, over the years, materially reduce the winter weed problem in bermudagrass fields.

Summary

1. Controlled flaming controls winter annual weeds in Midland.
2. Early flaming can increase the weed problem by stimulating germination of summer annual weeds.
3. Flaming was inferior to sod-seeding in terms of weed control and total forage production.
4. Flaming increased forage yields and inproved forage quality when done just as bermuda started to green.
5. Flaming did not improve efficiency of nitrogen utilization.

Table 1. Percent weeds, total yields, and percent nitrogen in the harvested forage as influenced by flaming, nitrogen fertilization and sod seeding.

Treatment	Nitrogen	Weeds in 1st two cuts		Total Yields[2]		Forage Nitrogen
		5-26	7-1	Midland + rye	Midland + rye + weeds	5-26
	LBS/A	%	%	T/A	T/A	%
Check	200	52	11	5.40 g[1]	5.96 e[1]	3.05 e[1]
	400	44	8	6.32 ef	6.88 cd	3.27 d
	800	42	7	6.92 cd	7.52 b	3.53 c
	Av.	46	8	6.21 C	6.79 B	3.28 C
Early Flame	200	45	15	4.92 h	5.45 f	3.02 e
	400	29	14	6.27 f	6.84 d	3.41 cd
	800	27	7	7.22 cd	7.65 b	3.79 b
	Av.	32	12	6.14 C	6.65 B	3.41 BC
Late Flame	200	27	6	5.90 fg	6.12 e	3.51 c
	400	28	6	6.83 de	7.10 c	3.97 b
	800	6	4	7.77 ab	7.93 ab	4.39 a
	Av.	20	5	6.84 B	7.02 AB	3.96 A
Sod Seed	200	5	8	6.20 f	6.34 e	2.97 e
	400	8	6	7.40 bc	7.55 b	3.54 c
	800	5	7	8.13 a	8.30 a	3.97 b
	Av.	7	7	7.24 A	7.40 A	3.49 B
Average:	200	32	10	5.61 Z	5.97 Z	3.14 Z
	400	27	8	6.71 Y	7.07 Y	3.55 Y
	800	20	6	7.51 X	7.85 X	3.92 X
CV %				5.5	4.8	4.2

1/ Values within each column followed by the same letter are from the same statistical population at the 5% level of significance (ABC-Treatment; XYZ - nitrogen; abcef - T x N).

2/ Five harvests for sod-seed treatments and four for all others.

Table 2. Pounds of N removed with harvested forage and percent of applied N recovered. Experiment 2, 1970.

Flame	Nitrogen Source	lbs/A	Harvest Dates 6-1	7-6	8-10	9-18	Total	Percent of applied N recovered
			lbs/A	lbs/A	lbs/A	lbs/A	lbs/A	%
Yes	NH_4NO_3	200	18	76	67	38	119	60
		400	33	107	123	69	332	83
		800	38	140	144	83	405	51
		Av.	30	108	111	63	285	65
	Urea	200	14	73	67	48	202	101
		400	23	98	111	64	296	74
		800	42	142	141	79	404	51
		Av.	26	104	106	63	299	75
No	NH_4NO_3	200	35	62	69	40	206	103
		400	46	83	114	67	310	78
		800	53	122	151	81	407	51
		Av.	45	89	111	63	308	77
	Urea	200	34	58	67	43	202	101
		400	39	102	119	64	324	81
		800	50	128	139	86	403	50
		Av.	41	96	108	64	310	77

Plant Environmental Studies With Turf

D. T. Hawes and A. M. Decker
Department of Agronomy

Purpose and Objectives

The purpose of the experiment was to study the responses of turf species to controlled soil temperature in the field, under otherwise "natural" environment. Much research as been conducted in the field under "natural" conditions where environmental variables may be measured, but not controlled. At the other end of the scale, growth chamber experiments provide us with plant responses to rigidly controlled and monitored environments. Both types of studies have contributed to a better understanding of plant growth, but much remains unanswered.

The first objective of this study was to take a closer look at the reactions of creeping bentgrass to modified soil temperatures in the field. The second was to observe responses of three other turf species to the same temperature regimes. These objectives were designed to gain basic information about plant-environment interactions and practical means of maintaining good turf during periods of adverse soil temperatures.

Procedures

A. Penncross bentgrass study:

Sod of Penncross bentgrass was laid May 1st, 1969 on two replications of the soil temperature controlled plots. A split plot experimental design was employed consisting of the following:

1. Main plots of ambient 10C, 21C and 32C soil temperatures.
2. Sub-plots of preventative vs. curative pythium control using Koban.
3. Sub-sub-plots with fertilizer levels of,
   (1) 1 lb. N/1000 sq. ft. in early June followed by four 1 lb. rates between June and September plus 8 lbs. N in October.
   (2) 1 lb. N in early June followed by four $\frac{1}{2}$-lb. rates between June and September plus 4 lbs. N in October.
   (3) Same as No. 2 plus potash at one-half the N rates.
   (4) Same as No. 3 plus minor elements.
   (5) 1 lb. N in early June followed by four one-eighth lb. rates June to September plus 2 lbs. N in October.

Ureaformaldehyde (UF) and potassium sulfate were the N and K sources in 1969. In 1970 the sub-plots were changed from pythium control to sources of nitrogen with fertilizer levels as follows:

1. Ureaformaldehyde in single applications on May 1st
   (1) 6 lbs. N/1000 sq. ft.
   (2) 3 lbs. N
   (3) 3 lbs. N plus potash at 1.5 lbs.
   (4) 3 lbs. N plus potash at 1.5 lbs. plus minor elements
   (5) $1\frac{1}{2}$ lbs. N
2. Ammonium Nitrate in split applications at two-thirds the UF rates to keep available N equal at similar fertility levels. One lb. N/1000 sq. ft. was applied in late March to all five fertility levels. Level #1 received $\frac{1}{2}$-lb. N every two weeks thereafter until a total of 4 lbs. N was applied. Levels 2, 3 and 4 received $\frac{1}{4}$-lb. N every two weeks thereafter until a total of 2 lbs. was applied.

Turf color readings were made weekly with a Ratiospect. Two-inch plugs were taken every two weeks from each treatment. Some were placed in a dark growth chamber for etiolated regrowth measurements and others were used to obtain root and tiller development data. Rate of cover measurements were determined by observations on bare spots created by placing the above 2-inch plugs with inverted plugs.

B. Observation Plots (Merion Kentucky bluegrass, Tufcote bermudagrass, Ky-31 tall fescue):

Sepcies were sodded May 1st, 1969 and plant responses observed. Data collection was similar to that used for bentgrass, but was taken less frequently.

Results

Plant responses to temperature differences were striking. At 32C, the cool season grasses were under considerable stress while bermudagrass flourished. At this temperature, an additional stress was caused by the high level of nitrogen on the bentgrass.

The number of stolons per given area in the bentgrass reached a peak in July. At this time, the number of stolons on the ambient plots averaged 30% higher than all other plots. Stolon counts in June were higher at 32C and 21C than at 10C; while in August 32C plots had fewer stolons than all other temperatures. The number of stolons increased with increasing rates of nitrogen and most significantly at 10C.

Clipping yields on the bentgrass were greatest on the ambient and 21C plots. 32C plots outyielded 10C plots with most of this yield coming in the spring.

The greatest differences in rate of cover were related to temperature. The coverage at 10C remained far below the other three temperature plots all summer. As the summer progressed, the coverage at 32C dropped significantly below the 21C and ambient plots. Ambient plots had a significantly higher average cover than 21C over all six periods for which data

were taken. Temperature average for 21C and ambient plots were similar, so it can be concluded that the greater diurnal temperature fluctuations on the ambient plots stimulated more growth.

Rate of coverage was positively correlated with clipping yields. The level of nitrogen was positively correlated with coverage. This correlation became less pronounced at the end of the summer when no nitrogen applications were being made. Except for the 32C plots, the higher the N level the greater the coverage, although there was often no significant difference between the two higher levels in August.

At 32C, the low level of nitrogen gave significantly better coverage than the high level during the first three weeks in August. The high level of nitrogen at this temperature resulted in a thinner turf with essentially no stored carbohydrates as determined by etiolated growth measurements.

Reflectance readings had a low coefficient of variability (4.5%) and showed clear differences between temperature plots. Ambient and 21C plots maintained a high level of green color throughout the summer. 32C plots declined in color due to thinning. Plots at 10C never obtained a high level of green color, except on the high level ammonium nitrate plots. Differences between nitrogen levels were greater at 10C than at other temperatures.

Width of blades were wider on the bentgrass at 10C than at 32C.

Etiolated growth was highest from the 10C plots and lowest from the 32C plots. The high nitrogen level produced the most etiolated growth, except at 32C in late summer of 1970 when the reverse was true. At 10C

etiolated growth increased more with each increase in nitrogen level than it did at other temperatures.

Total roots and healthy, large, white roots (H.L.W.R.) both reached a peak in June of 1970; this peak was not significantly higher than the July, 1970 average for total roots but was significant at the 5% level for H.L.W.R. In numerous other cases the more sensitive measure of plant response was the H.L.W.R.

The amount of thatch or accumulated organic matter for the bentgrass was much greater at 10C than 32C, as might be expected from knowledge of the rates of organic matter decay at these two temperatures.

With Tufcote bermudagrass on 21C and 32C plots, we were able to maintain green color and some growth up until mid-December, when temperature controls were shut off for the winter. Furthermore, this did not result in winter kill as expected. New bermuda sod laid on the 21C and 32C plots in October survived the winter in excellent condition, while that laid on 10C and ambient plots largely winter killed.

There was too much data to include it all in this report. Data will be found in the Ph.D. thesis of the major author.

Summary

1. Soil temperature affected all measured plant responses.
2. The level of nitrogen was positively correlated with coverage at the cooler temperature, but negatively correlated at 32C in August.
3. Rate of coverage was positively correlated with clipping yields.
4. Bentgrass blades were wider at 10C than at 32C.

5. Number of bentgrass roots reached a peak in June for all plots. Greatest numbers of roots were produced at 10C and least as 32C.
6. Accumulation of organic matter was greater for bentgrass at 10C than at 32C.
7. Maintaining soil temperatures of 21 and 32C under bermudagrass maintained color in early winter without winterkill.

Forage Double-Cropping Utilizing No-Tillage Planting

Lenat Hofmann
Department of Agronomy

Purpose and Objectives

No-tillage planting of corn has been a successful method of obtaining good grain yields, usually with a substantial saving of time. The most commonly recommended no-tillage practice is to plant a small grain cover crop in the fall. The next spring the cover is killed with paraquat before corn planting. The corn is drilled directly into the cover crop mulch. No-tillage corn can also be successfully planted into a grain stubble.

Small grains, when harvested about early dough stage, make excellent forage. Since a grain cover crop is recommended for no-tillage planting, it would appear that there is a potential for double-cropping the small grain and corn for silage. Since neither the grain nor the corn are grown to maturity. when utilized for silage, the length of growing season is not a major factor. The biggest drawback of double cropping using a conventional planting is the length of time required to prepare a seedbed after grain harvest for corn planting. No-tillage planting circumvents this problem because as soon as the grain is harvested, corn can be planted directly into the stubble.

Increasing yields and efficient crop production are the major factors for determining the feasibility of a forage, double cropping program. The primary purpose of this experiment was to compare yields of silage from full-season corn production to yields of silage from small grain plus corn in a double crop system. In addition, no-tillage planting methods were compared to conventional planting methods.

Procedures

The experiment was initiated in the spring of 1970 at the University Forage Research Farm, Clarksville, Maryland. The experiment was replicated three times in a split-plot design with 3 planting dates (early, full-season corn; medium, small grain for silage and corn for silage; and late, small grain for grain and corn for silage) as whole plots; sub-plot treatments were a conventional planting and a no-tillage planting method.

Pioneer 3306 corn was planted on May 13, 1970 for the early planting and on May 22 for the medium planting. Dekalb XL45, a shorter season hybrid was planted on June 29. These dates represented full season, barley for silage, and barley for grain harvests, respectively. Conventionally planted plots were plowed and prepared within a week of each planting treatment. The early no-tillage plots were planted into a rye mulch which had been killed with 1 lb/A paraquat plus 8 ounces of Ortho X-77 spreader per 100 gallons of water when the rye was about 24 inches tall. The medium and late no-tillage treatments were planted into rye stubble which was also sprayed with paraquat.

Conventional plots received 130 lb/A each nitrogen, phosphate and potash plowed down plus 20 lb/A with the planter and no-tillage plots received similar amounts top dressed. Conventional plots had a 1 lb/A each (AAtrex) and butylate (Sutan) preplant incorporated and the no-tillage plots received 1 lb/A atrazine and 1.5 lb/A alachlor (Lasso) preemergent. On June 3, the early treatment was sprayed with 2 lb/A atrazine plus oil postemergent to control yellow nutsedge. The medium treatment received similar application on June 18.

Six rows from each treatment of the early and medium plots were harvested on September 18, 1970, with a field forage harvested. Wagons were weighed after each plot was harvested, a moisture sample was taken and all yields were corrected to 35% dry matter. The late treatment was similarly harvested September 30.

Results

Small grain silage and grain yields were not obtained in 1970. Corn silage yields are shown in Table 1.

The results of the first season indicated that silage yields were significantly reduced by using no-tillage planting methods, especially with the earlier planting dates. The no-tillage corn plants visually appeared to have symptoms of low fertility, especially nitrogen. Some of the differences may have been due to the different methods of fertilizer application. In 1971, higher fertility rates will be used and both planting methods will utilize a band application of part of the fertilizer with the planter.

Weeds, especially nutsedge appeared to be severe, but did not present problems later in the season. The relatively heavy atrazine rates (total of 3 lb/A) did not affect the establishment of either rye or barley planted the following fall.

Summary

The study will be continued for at least two more years. This type of study often requires time for the full effects of the different cultural practices to show. Small grain for silage, small grain for grain, and both corn silage and grain yields will be taken in the future to determine if double cropping for forage production has a potential in Maryland.

Table 1. Tons/A (35% dry matter) corn silage at three dates of conventional and no-tillage corn at 30 inch row spacings.

Date of Planting	Tons per acre		
	Conventional	No-Tillage	Average
Early (May 13, 1970)	21.9 a [a/]	17.3 b	19.6
Medium (May 22, 1970)	18.6 b	14.2 c	16.4
Late (June 29, 1970)	11.1 d	10.6 d	10.9
Average	17.2	14.0	

a/ Numbers followed by the same letter are not significantly different at the 5% level of probability according to Duncan's Multiple Range Test.

The Feasibility of Transplanting Tobacco Seedlings in Pressed Peat-Soil Cubes

J. H. Hoyert
Department of Agronomy

Purpose and Objectives

The purpose of this research was to develop new methods of growing tobacco plants which would have a potential for improving seedling uniformity. Thus further mechanization of transplanting and a reduction in labor might be achieved. Irregular tobacco at harvest time because of non-uniform transplants is one of the major problems in total mechanization of tobacco production.

The objectives of this study were:

1. To compare the growth and uniformity of transplants in peat-soil cubes to conventional transplants.
2. To investigate the feasibility of discontinuing the use of water with peat-soil cubes.

Procedure

This experiment was situated on a Monmouth fine sandy loam soil at the Tobacco Experimental Farm. Md. 59 variety was transplanted using a modified Ellis 2-row mechanical transplanter at a plant population of 6,223 per acre. Fertilizer was broadcast at a rate of 60-120-180 lbs. per acre. Experimental design was a randomized complete block with 4 replicates. Plots were 2-rows of 18 plants or 6 by 42 ft. in size.

Treatments included were pressed peat-soil cubes (approximately 20% soil, 50% sphagnum peat, 20% vermiculite and 10% perlite by volume) and transplants pulled from a plant bed and carefully sorted and selected according to uniformity of size and shape. The control consisted of con-

ventional transplants pulled rapidly as an average grower draws seedlings with no extra attention given to uniformity. Each of these treatments were transplanted with 1/2-pint of water placed at the roots during the planting operation. The three treatments were also repeated with no water used at transplanting making a total of six treatments.

Transplanting was carried out on June 10, 1970. This was a very dry period with 27 days of deficient rainfall from May 26th through June 25th. Total rain during this period was 1.61 inches and no one rain exceeded 0.50 inches. Under this severe moisture stress a transplant with intact roots such as the cubes could be expected to perform better than the conventional plant which has most of its roots stripped off in the pulling operation.

Ratings of early growth, vigor and uniformity were made 3 weeks after transplanting by four observers on a 1 to 10 basis with 10 being a perfect plot. Estimates of relative uniformity were based on plant to plant variation within individual plots using measurements of the cured tobacco. Yield per acre, price per hundredweight and acre values were also determined.

Results

The field results are presented in Table 1 and indicate that under moisture stress conditions the cube transplant was superior to the control in yield, value uniformity and early growth ratings. The cube transplant with water at planting was the most uniform. In general the use of water at planting was a definite advantage over no water as might be expected. The cube transplant was the only treatment without transplant water to be feasible.

Quality as indicated by price did not show any significant differences.

Summary

1. The cube transplant performed better than the control and was consistently superior to the specially selected transplant although this difference was not significant.
2. The cube transplant was very satisfactory when no water was used at transplanting exceeding both the specially selected transplant and the control at the 1% level of significance.

These differences favoring the cube plants with intact roots were undoubtedly magnified by the dry period during transplanting.

Table 1. Yield, price, acre value, uniformity and early growth rating of various types of tobacco transplants. 1970.

Treatment	Yield lbs/A	Price $/cwt.	Value $/A	Estimates of [1] relative uniformity	Rating of [2] early growth
(with transplant water)					
Control	1352	71.69	969	100	6.33
Peat-soil cube	1539	73.50	1131	655	8.40
Selected plant	1491	72.82	1089	186	7.88
(without transplant water)					
Control	1133	72.46	821	68	3.54
Peat-soil cube	1572	72.86	1146	495	6.94
Selected plant	1265	72.05	911	131	4.33
L.S.D. (.05)	143	N.S.	116		
(.01)	195	N.S.	159		
C.V. (%)	7.8	2.0	8.7		

1/ Plant to plant variation.

2/ Average of 4 observers on scale of 1 to 10 with 10 best.

Effect of Diphenamid on Weed Control and Tobacco Seedling Production

J. H. Hoyert
Department of Agronomy

Purpose and Objectives

Diphenamid sold under the trade name of Enide has been very successful in controlling grass in field tobacco in Maryland and other areas. There has been considerable interest in the effectiveness of this material for use in controlling grassy and broadleaved weeds in tobacco plant beds. Diphenamid is very inexpensive and can be applied more conveniently and rapidly than materials now being used in Maryland. However preliminary work in the greenhouse indicated that there was some risk in injuring the tobacco seedlings at germination.

Objectives of this work were to study the effect of diphenamid for the control of grassy and broadleaved weeds in a conventional tobacco plant bed and determine the yield of seedlings pulled for transplanting. Special attention was paid to phytotoxicity effects of this material on germinating seedlings.

Procedures

The experimental design was randomized complete block with four replicates situated in the regular plant bed area of the Tobacco Experimental Farm on Monmouth sandy loam soil. Md. 59 variety was seeded on April 8, 1970 in a conventional manner. Irrigation was used frequently during the germination period.

The diphenamid was sprayed over the plots on April 9, 1970. Treatments were 0 lb/A; 2 lb/A (active); 4 lb/A (active), 6 lb/A (active) and 8 lb/A (active) with 40 gallons of water per acre used for each treatment.

Plot size was 4.75 ft. x 9 ft.; however, to minimize border effect all data was recorded for 2.5 ft. x 6.4 ft. Data included grassy and broadleaved weed count on May 8, 1970 and number of transplants pulled on June 3, 1970.

Results

Table 1 presents a summary of results from 1970. All rates of diphenamid were better than the control in the number of good transplants drawn for field use. There were no significant differences among the various rates of diphenamid in numbers of transplants.

The material was effective for grassy weed control with all rates being superior to the control. The 4, 6 and 8 lb/A rates of active were better in controlling grassy weeds than the 2 lb/A rate. There were no differences between treatments in the control of broadleaved weeds, although the trend indicated high rates gave some degree of weed control. No observations were made of leaf distortion in the very early growth period. However the 6 and 8 lb/A rates resulted in the young seedlings growing slower but this was not evident at time of pulling transplants for the field.

Summary

In 1970 diphenamid gave satisfactory grassy weed control. Control of broadleaved weeds was inadequate. There was no indication of injury to the young tobacco seedlings although the higher rates of 6 and 8 lb/A were slow in early growth. This material should be tested further before general recommendations can be made to growers.

Table 1. Effect of diphenamide on weed control and tobacco transplant production. 1970.

Diphenamide lbs. per acre/active	Count per 16 sq. ft. Grass	Broadleaf Weeds	Tobacco Transplants
0	862	160	8.8
2	462	87	63.8
4	186	101	55.8
6	53	107	51.8
8	43	44	56.8
L.S.D. (.05)	320	N.S.	21.9
(.01)	448	N.S.	30.7
C.V.	62%	54%	30%

Effect of Sucker Control Agents, Method of Application and Time of Harvest on Maryland Tobacco

J. H. Hoyert
Department of Agronomy

Purpose and Objectives

Maryland growers have changed widely to the use of sucker control chemicals in the past few years. There are practical problems in the application of suckering agents brought on by the reliance of many large growers on custom operators. It is necessary for the custom operator to treat the grower's total tobacco acreage in one visit as it would be too costly to make repeat visits to the farm. It is often impossible for the grower to top his entire crop because of labor restrictions. Thus there are practical advantages for custom operators to apply sucker control agents to untopped tobacco.

Another problem resulting from decreased labor availability is that tobacco is harvested over longer periods of time after topping which could have a significant effect on quality and yield. Maryland leaf is noted for its thin body and high filling power -- quality characteristics that must be preserved.

Systemic sucker control agents are most popular in Maryland but contact type chemicals have some place on small crop acreages. Combinations of systemic and contact sucker control agents have proven profitable in the flue-cured area and should be investigated under Maryland conditions which are considerably different than flue-cured.

Consequently this study was initiated to compare sucker control agents and different methods of application. The objectives were:

1. To compare systemic (maleic hydrazide), contact (Penar), a combination of contact and systemic agents and the application of a systemic sucker control agent before topping and the effect on yield, price and acre values of Maryland tobacco.
2. To determine the effect of time between treatment and harvest for various sucker control methods, on yield, price and acre values.

Procedures

This experiment was located on a Monmouth fine sandy loam at the Tobacco Experimental Farm. Md. 10 variety was transplanted at a population of 6,223 plants per acre with 60-120-180 lbs. of fertilizer broadcast per acre and an additional 20 lbs. of nitrogen sidedressed 30 days after planting. Four replicates were used in a split plot design with the time of harvest as sub plots and sucker control methods as the whole plots.

Transplanting was carried out on May 30, 1970 and topping was completed August 4, 1970 when approximately 90% of the plants showed open flowers.

Treatments were:

1. Control -- Topped August 4, 1970 with no sucker control used.
2. Systemic -- Topped August 4 and sprayed with MH-30 at 1 pint per 1000 plants.
3. Systemic -- MH-30 at 1 pint per 1000 plants sprayed on July 31 and topped August 4.
4. Contact -- Topped August 4 and Penar applied.
5. Contact + systemic -- Penar applied July 31, topped on August 4 and sprayed with MH-30.

There were two harvest dates of August 13, 1970 and August 24, 1970.

Yield, price per pound and acre values were computed for the cured leaf using the standard grades as established by Tobacco Division of the Consumer and Marketing Service of the U. S. D. A.

Results

Conditions were not beneficial for sucker growth so there were no differences between the amount of suckers resulting from the different treatments. Rainfall totaled only 0.54 inches during the period of August 1 to August 20 when sucker growth would normally have been at its maximum. The 1970 results are summarized in Table 1. Statistical analysis were not yet available so trends only will be indicated herein. The yield per acre was unaffected by the various treatments used in this test. There was a tendency for lower yields in the late harvest of August 24, 1970 in the control treatment and the maleic hydrazide applied at time of topping. This was primarily because of excess "firing" and loss of lower leaves in these treatments.

Price per hundredweight of tobacco showed a major difference of consistently lowered price at the later harvest date. This was because of thicker bodied leaf resulting from this late harvest and in part because there was a larger proportion of lower value "second" grades and less of the higher valued "bright" leaf grades.

The acre values were not significantly different for any of the treatments used. There was an interesting trend for the MH-30 applied before topping to result in higher acre values at the late harvest date and this should be watched in the coming year.

Summary

The later harvest date resulted in slight losses in yield per acre and significant decreases in price per pound. There were no important differences among the chemicals used for sucker control. Conditions favored only minimum sucker growth so that there was no stress placed on the plants by suckers.

The systemic applied before topping appeared very promising and this method of application would be advantageous to many Maryland growers.

Treatment No.	Rates of CEPA	Time of Application	Time of Harvest
1	75 mgs per plant	Aug. 6, 1970	Aug. 18, 1970
2	150 " " "	Aug. 6, 1970	Aug. 18, 1970
3	75 " " "	Aug. 10, 1970	Aug. 18, 1970
4	150 " " "	Aug. 10, 1970	Aug. 18, 1970
5	75 " " "	Aug. 14, 1970	Aug. 18, 1970
6	150 " " "	Aug. 14, 1970	Aug. 18, 1970
7	75 " " "	Aug. 18, 1970	Aug. 21, 1970
8	150 " " "	Aug. 18, 1970	Aug. 21, 1970
9	75 " " "	Aug. 22, 1970	Aug. 25, 1970
10	150 " " "	Aug. 22, 1970	Aug. 25, 1970

The chemical was added to water to bring total volume up to 20 ml per plant and sprayed in a fine mist over the entire plant. The test was designed to be harvested 10 days after treatment with CEPA. The variation in time of application was to determine the effect of maturity of the plant upon response to CEPA.

Results

CEPA caused premature "firing" and loss of bottom leaves at a rapid rate. It was necessary to harvest earlier after this was discovered and tobacco in treatments 5 through 10 was cut 3 to 4 days after application of the material. In addition CEPA caused the leaves to turn a very definite yellow color similar to ripeness within four days of application.

Table 1 presents the yield, price and acre values of tobacco in 1970. There were no significant differences in yield per acre from the treatments studied. Treatments 5, 6 and 8 resulted in high prices and showed promise for future experiments. Acre values indicated that treatments 5 and 6 were favorable. Treatments 1 and 4 were unsatisfactory.

Summary

This preliminary work with CEPA indicated that it caused premature loss of lower leaves of the plant. There was a striking yellowing of treated leaves within four days of application. The treatments applied 9 days after topping appeared to be promising. Further work should be carried out and include investigations of maturity at time of application and harvest dates must be not more than four days after treatment with CEPA.

Table 1. Effect of CEPA on yield, price and acre values of Maryland tobacco. 1970.

Treatment No.	Yield lbs/A	Price $/cwt.	Value $/A
1	995	70.69	700
2	1130	68.73	775
3	1376	69.73	971
4	939	68.65	642
5	1382	76.47	1053
6	1516	72.78	1100
7	1053	69.08	734
8	1225	73.25	895
9	1218	69.26	844
10	1131	67.38	778
L.S.D. (.05)	N.S.	4.16	285
(.01)	N.S.	5.62	N.S.
C.V. (%)	22.7	4.1	23.2

Tobacco Topping Studies

C. G. McKee
Department of Agronomy

Purpose and Objectives

1. To investigate the potential of chemicals for topping Maryland tobacco. Contact-type chemicals have long been used for sucker control in the tobacco area. If a contact acting chemical can be satisfactorily used to kill the flower bud, it would save one operation that is now carried out by hand.
2. To study the effects of various hand topping methods on the yield, quality, chemical content and physical characteristics of Maryland tobacco. Topping practices can influence time of ripening and the uniformity of the cured plants. Low, early topping could be used to gain an extra week of harvesting thus spreading out labor. More uniformity of the cured plants will speed stripping and grading and would be better adapted to mechanization.

Procedure

1. The chemical-topping studies were set up with four treatments: chemical topping using 1-decanol, bud topping, early bloom topping and early bloom topping with chemical sucker control using T-148. Md. 609 variety was used for this test.
2. Methods of Hand Topping

   Earlier work indicated some advantages to low topping in that the tobacco could be harvested earlier and grading was easier because there were fewer sorts to be made. A study was started in 1967 testing 3 methods of low topping height compared with 3 methods of medium or normal topping height. Treatments tested were:

Treat. No.	Topping height	Topping time
1	Low - 13 leaves harvested	early - before flower
2	Low - 13 leaves harvested	allow to flower & break down
3	Low - 13 leaves harvested	bud top and re-top
4	Medium - 18 leaves harvested	before flower
5	Medium - 18 leaves harvested	at flower
6	Medium - 18 leaves harvested	bud top and re-top

Results

1. Results for chemical topping are summarized in Table 1. The chemical topping treatment resulted in the highest yield per acre, but the lowest price/lb. The dollar value of this treatment was above the bud topping and early bloom topping treatments, but less than the early bloom topping with T-148 sucker control.

2. The results for the methods of hand topping test are given in Table 2. The low top treatments, 1, 2 and 3, were lower in yield, price per pound and acre value than the medium topping treatments, 4, 5 and 6. Treatment 1, topped early before flower, resulted in tobacco with a low filling capacity and a high percentage of total nitrogen and total alkaloids. These are all undesirable characteristics for Maryland tobacco.

Summary

The results from the chemical topping study indicate that 1-decanol can be satisfactorily used to kill the terminal bud and thus "top" tobacco. This chemical also gives sucker control. Thus, one application can be used to both top and control suckers. 1-decanol received an experimental label for use on the 1971 tobacco crop.

The results from the hand topping test indicate that tobacco cannot be topped to a low leaf number without suffering considerable loss in both yield and quality. These results are similar to the previous year's results, but completely contrary to the results from 2 years ago. This indicates rather large seasonal differences depending on moisture conditions.

Table 1. Chemical Topping.

Treatment	Yield - lbs/acre	Price/lb. - cents	$/acre
1. Chemical topped	2035	62.9	1298
2. Bud topped	1804	69.3	1249
3. Early bloom topping (normal)	1854	67.5	1252
4. Early bloom topping + T-148	2008	68.9	1382

Table 2. Results of experiments on various methods of hand topping.

Treatment	Yield Lbs/Acre	Price/lb. Cents	$/Acre	% Total Nitrogen	% Total Alkaloids	Filling Capacity cc/gram
1	1569	55	866	3.95	2.80	4.1
2	1505	58	877	3.10	2.13	5.4
3	1388	62	864	2.72	1.39	5.7
4	1726	72	1247	2.62	2.31	5.1
5	1996	70	1383	2.97	2.48	5.1
6	1726	70	1199	2.59	2.00	6.0

Irrigation with Maryland Tobacco

C. G. McKee
Department of Agronomy

Purpose and Objectives

Previous research has indicated that the investment in irrigation equipment can be justified on most tobacco producing farms in Southern Maryland. The number of acres of tobacco that is presently irrigated is still relatively small -- 10 to 15% of the total, but it is increasing every year. Previous work also indicated that some varieties respond differently than others to higher nitrogen levels when adequate moisture is available.

The objective of this research is to determine the differential response of the released Maryland varieties and advanced breeding lines to nitrogen levels under optimum soil moisture conditions.

Procedures

The experiment was a split-split-plot design. Main plots were irrigation vs. no irrigation. The first split was nitrogen rate -- 70 and 100 pounds per acre and the second split was variety -- Catterton, Md. 64, Md. 59, Md. 609, Md. 10 and breeding line 102. There were four replicates for a total of 96 plots.

The experiment was located at the University of Maryland Tobacco Experimental Farm. The soil was Monmouth loamy fine sand. The initial fertilizer application of 60 lbs. nitrogen, 120 lbs. P_2O_5 and 180 lbs. K_2O was broadcast and disked in prior to planting. The additional nitrogen necessary was applied as a sidedressing 2 weeks after transplanting.

Water was applied to the plots requiring irrigation when tensiometers set at 6-8" were reading 50 or above and the plants were showing slight wilting in the heat of the day. A Skinner irrigation system was used that applied approximately 1/4 inch of water per hour.

Results

The 1970 growing season was a very good one for Maryland tobacco. One dry period occurred as the crop was approaching maturity and 1½ inches of water was applied to the irrigated plots. This was the only water applied during the season.

The results for 1970 are in Table 1. The major response was to nitrogen. Plots receiving 90 lbs. of N averaged $190 more per acre than those receiving 70 lbs. of N. The irrigated tobacco averaged 2 cents more in price per pound than the non-irrigated tobacco. The tobacco was "full grown" when water was applied and only needed water to mature properly. The increase in price per pound plus some increase in yield resulted in the irrigated tobacco averaging $60 per acre more than the non-irrigated tobacco.

Summary

This was the second year for this test. Tests with irrigation have to be conducted over a number of years to get meaningful results.

Table 1. Summary of the Irrigation Test with Tobacco -- 1970.

Yield -- Pounds/Acre

Variety	Irrigated		Non-Irrigated	
	Low N	High N	Low N	High N
Catterton	1411	1558	1246	1714
Md. 64	1887	2126	1844	2047
Md. 59	1416	1759	1348	1623
Md. 609	1589	1763	1597	1729
BL 102	1703	1971	1609	2089
Md. 10	1478	1624	1405	1621
Average	1581	1800	1508	1804

Average Price/Pound -- Cents

Variety	Irrigated		Non-Irrigated	
	Low N	High N	Low N	High N
Catterton	72	74	69	71
Md. 64	73	74	70	69
Md. 59	74	73	74	74
Md. 609	77	76	75	76
BL 102	71	72	69	69
Md. 10	72	72	71	71
Average	73	73	71	71

Dollars/Acre

Variety	Irrigated		Non-Irrigated	
	Low N	High N	Low N	High N
Catterton	1025	1157	858	1213
Md. 64	1375	1567	1283	1408
Md. 59	1049	1279	992	1197
Md. 609	1230	1341	1197	1313
BL 102	1208	1409	1106	1442
Md. 10	1066	1175	1001	1155
Average	1159	1321	1073	1288

Effects of Air Pollution on Maryland Tobacco Varieties

C. L. Mulchi
Department of Agronomy

Purpose and Objectives

Tobacco as a species has been found to be highly sensitive to air pollutants, particularly to the oxidants such as ozone, nitrogen dioxide and sulfur dioxide. Shade grown varieties were the first agricultural crops on the East Coast to exhibit symptoms of air pollution damage. Since the early 1950's, the frequency of vegetative damage from air pollution has been increasing. The most common air pollutants in the Washington-Baltimore area are the oxides of nitrogen, sulfur dioxide and ozone. Ozone is produced photochemically by the action of light on a combination of hydrocarbons from vehicle exhaust, etc., and nitrogen dioxide in the atmosphere. Ozone levels commonly reach 0.1 ppm and above in the atmosphere during the summer months in the Washington area. Long term exposure to 0.1 to 0.2 ppm ozone by Maryland type tobacco varieties causes a characteristic "flecking" of the upper surface of the leaves when they are reaching maximum elongation. The symptoms remain when the product is cured, thus lowers the quality of the leaf product.

From preliminary field studies in 1970 at several locations in southern Maryland, information was obtained on the susceptibility of Maryland varieties to ozone and sulfur dioxide. The field data indicated that a wide range of susceptibility existed in the varieties which are available to growers. Varieties such as Catterton, Md. 10 and Md. 59 appear to have a much lower resistance to ozone damage than varieties such as Wilson and Md. 64. Limited information is available on what physiological and biochemical processes are damaged by the oxidants. Virtually nothing is known about the genetical

relationship regulating the susceptibility of plants to air pollution damage. The objectives of this study are:

1. To quantify the genetical relationship which regulate the susceptibility of tobacco to ozone and other pollutants.
2. To investigate the effects of ozone and other pollutants on certain physiological and biochemical processes in an effort to determine which processes are associated with resistance to air pollution damage.

Procedures

Before experiments relating to this study could be planned and carried out, facilities and equipment had to be purchased or built. An air-tight fumigation chamber which has a 4' x 8' plant bed was designed and constructed with the aid of the Department of Agricultural Engineering. The chamber is equipped with activated charcoal filters on the air intake blower (50 CFM) and dual exhaust ports, air conditioning for temperature control, internal air circulation system and a lighting system composed of a mixture of Grow Lux lamps and normal incandescent lamps. The light intensity equals about 1000 ft-c at the plant level. Ozone can be injected into the chamber from cylinders or manufactured from air or pure oxygen with an ozone generator.

Several preliminary studies were conducted in an effort to determine the optimum operating conditions and procedures. One such experiment is described in this report. Since the studies thus far have been preliminary, it serves little purpose for reporting on all such studies.

Tobacco plants from Catterton, Wilson, Md. 609 varieties and M871, M872, and M881, advanced breeding lines, were grown in soil-peat mixtures in 4-inch pots in the greenhouse until their sixth leaf had reached maximum elongation. Four plants of each variety were placed in the chamber and allowed to equilibriate for one hour before exposure to ozone. The temperature was maintained at $80 \pm 2^{o}F$ and the relative humidity remained at $47 \pm 3\%$.

The plants were exposed to air containing 0.81 ppm ozone for a period of three hours then returned to the greenhouse. Symptoms were visible at the time of removal but became more pronounced during the following two days. On the third day following fumigation, the leaves were examined and estimates of the areas damaged were made.

Results

Data from the experiment described above are summarized in Table 1. In general, the data agrees with that obtained from field studies. Catterton had the most leaves damaged and the largest estimated area of damage on the leaves exhibiting symptoms. Wilson and M871 appear to have the lowest susceptibility to ozone with Md. 609, M872 and M881 appearing intermediate or moderately susceptible. However, the type of symptoms expressed were more massive than commonly observed in the field. This was believed to be associated with the high concentration of ozone used. In later studies, the concentration of ozone was lowered to 0.5 ppm, the exposure time increased to four hours and the relative humidity was increased to $75 \pm 10\%$. The lower concentration produced symptoms more typical of those observed in the field.

Several other procedures were changed in subsequent preliminary studies. Uniformity in symptom expression among plants within a variety was observed to be improved by selecting for physiological age - i.e. grouping plants with a common characteristic such as the eighth leaf at bud stage - rather than trying to measure the expansion of a given leaf. Also, uniformity in symptom expression could be improved by placing the plants in a standard dark pretreatment for 24 hours. The dark pretreatment lowers the variation in soluble carbohydrates which have been shown to be a factor in regulating plant susceptibility. However, the dark pretreatment tended to enhance the rate of senescence of the older leaves on the plant.

Various methods for scoring leaf damage have been tried. The objective was to develop a method which was rapid but which gave more accuracy than visual estimations. A grid method similar to that used for counting micro-organisms was selected.

Summary

A study to determine the genetical relationships regulating the susceptibility of Maryland tobacco varieties to air pollution and the physiological processes associated with plant resistance has been initiated. Several preliminary studies were conducted in an effort to determine the optimum working conditions and procedures for more detailed studies. Wilson and M871 appear to have the lowest susceptibility to ozone. Md. 609, M872, and M881 appear intermediate or moderately susceptible to ozone.

Table 1. Summary of Ozone Damage to Several Maryland Tobacco Varieties[a/] Subjected to 0.81 ppm Ozone for Three Hours (80±2°F, 47±3% R.H., 1000 ft-c).

Variety	Total Leaves per Plant	Injured Leaves per Plant	Damaged[b/] Area of Injury Leaves (%)
Wilson	12.3	3.8	14.1
Catterton	13.0	7.5	58.2
Md. 609	11.5	6.0	37.3
M871	11.3	4.0	9.0
M872	10.5	4.5	25.5
M881	11.5	5.8	28.8

a/ Four plants of each variety were placed in the fumigation chamber. Plants were grown in the greenhouse until their sixth leaf was at maximum elongation.

b/ Estimated by visual observation for each leaf damaged. The results were accumulated for the plant as a whole.

Resistance to the Mexican Bean Beetle in Soybean Germplasm

P. E. Paz and J. A. Schillinger
Department of Agronomy

Purpose and Objectives

The Mexican bean beetle, Epilachna varivestis Muls, has become a serious pest on soybeans, especially in Maryland's Lower Eastern Shore and Virginia. Late maturing varieties are heavily infested and suffer the most. The purpose of this work was: (A) to find sources of resistance among the existing soybean germplasm of maturity groups III, IV and V, (B) elucidate mechanism(s) of resistance, (C) to determine economic losses in soybean production and (D) to study inheritance of resistance.

Procedures

(A). Germplasm Screenings:

Approximately 1200 strains have been screened at the two locations of Snow Hill and Poplar Hill in the summers of 1969 and 1970. The criteria used for selection of strains to be tested included: yield, % protein and oil, lodging index and pubescence type. The strains were planted in 6 meter single rows, with a row of snap beans interplanted every fourth row to concentrate the beetle population. The strains were scored three times during the growing season for Mexican bean beetle damage using a 1 to 10 scale (1 representing 10% of damaged foliage and 10 representing 100%). The strains were then selected according to their respective damage indexes.

Among the strains tested were 42 entries obtained from Dr. T. J. Smith of the Eastern Virginia Experiment Station at Warsaw, Virginia. These strains have PI 80837 in their parentage. PI 80837 is a group IV strain, with dense

pubescence and which was found to be resistant to the Mexican bean beetle in 1968.

(B). Mechanism(s) of Resistance:

The mechanism of resistance is not known and several studies were conducted to elucidate it.

i) Oviposition Preference: This was done in the summer of 1970 under a 3.6 x 15 x 2.4 meter, 20 x 20 Mesh Saran screenhouse. Ten entries, which included 3 susceptible varieties, 2 susceptible PI strains and 5 PI strains with different degrees of resistance, were planted in a randomized complete block design in 1.5 meter rows with eight replications. At bloom stage, approximately 1500 adult beetles were introduced in the screenhouse and oviposition counts were taken two weeks later. Larval and pupal counts were also taken twice and an overall damage score was taken at the time of the last egg count.

ii) Larval Survival: This was performed both in the field as well as in the lab under growth chamber conditions. Seven strains (York, 4 PI lines and 2 Virginia lines selected in the summer of 1970) were entered in this study. The strains were planted in 15 cm. clay pots in the greenhouse with four seeds to each pot and later the plants were thinned to one plant per pot. At about the fourth trifoliate stage, each pot was covered with a 20 x 20 mesh screen cage. Ten first instar larvae were added per plant and their weight recorded. The pots were then arranged in a randomized complete block design with eight replications in a 1.8 x 1.5 x 2.4 meter growth chamber with a temperature of 25°C. A week later the cages were removed and larval survival and final weights were recorded for each entry.

iii) Food Consumption: The same entries used for the larval survival test were used in this test. One trifoliate leaf was chosen from the mid-section of the plant and six 1 centimeter disks were punched out of each of the side trifoliate, leaving the center trifoliate intact. The disks were arranged in a 100 x 20 mm. Petri dish, which had a disk of Whatman's No. 1 filter paper moistened with 5 ml. of distilled water. Two third instar larvae, which had been starved for 24 hours, were added per disk, left to feed for 24 hours and then removed. The leaf disks were dried in an oven at 60°C for 24 hours and their dry weight recorded. These were then compared with disks set up on a similar manner to which no larvae had been added. The data was then analyzed as a randomized complete block.

(C). Economic Losses due to the Mexican Bean Beetle.

Twelve entries which were selected according to their degree and type of pubescence were included in this study. These comprised three standard varieties, York, Kent and Adelphia. Also included were PI 80837 and 81777, two dense pubescent strains with resistance, and used extensively in several breeding programs for good seed quality.

These entries were planted in a split plot design, having insecticide vs. no insecticide as main plots and soybean strains as subplots. They were planted in three 6 m. rows with four replications and two locations, Snow Hill and Poplar Hill. The plots that received insecticide treatment were sprayed every two weeks with 1.5 lbs/A (active ingredient) of Carbaryl (Sevin).

Two counts were taken during the growing season: one adult count at about the fourth trifoliate stage and one larval count at about the late pod filling stage. Both counts were taken in 0.6 m. of row which were selected at random.

Yield and size were recorded for the different strains and analyzed statistically.

(D). Inheritance of Resistance:

In the summer of 1970, selected resistant strains were crossed to three standard varieties, representing maturity groups IV, V and VI (Kent, York and Hood). The F_1 of these crosses was grown in the greenhouse and the F_2 space planted at the Poplar Hill Farm, where they are being scored for damage and insect population to study segregation of resistance.

Results

(A). Germplasm Screenings:

Several strains were selected as being resistant to the Mexican bean beetle using the damage indexes. These strains include:

STRAIN	MAT. GROUP	DEGREE OF RESISTANCE
PI 243517	IV	Moderately resistant
PI 243519	IV	Moderately resistant
PI 243515	IV	Resistant
V69-21	V	Resistant
V69-156	V	Moderately resistant
V69-197	V	Resistant
V69-289	V	Highly resistant

These strains will be used in further studies.

(B). Mechanism(s) of Resistance:

i) Oviposition Preference: Surprisingly, the highest number of egg masses was found on PI 80837; which is highly resistant. However, when the data were analyzed, no differences were found in number of eggs per plant.

ii) Larval Survival: Larvae that fed on York had the highest percentage of survival, while larvae that fed on V69-289 had the lowest percentage of survival. PI 80837, which is one of V289 parents, had the next lowest percentage of larval survival.

On analysis of the data, statistically significant differences were detected among the varieties at the 1% level of probability.

iii) Food Consumption: The larvae fed more readily on PI 80837 and PI 243517. Larval feeding on V69-21 and V69-289 was intermediate. No significant differences were detected between varieties when analyzed statistically, although visual differences were apparent.

(C). Economic Losses:

The economic losses as reflected in a reduction of yield were greater for the late maturing varieties, where as much as 50% reduction in yield was observed for D64-4731 and York. The standard varieties, Kent and Adelphia, were also affected although to a lesser extent. The moderately resistant strains PI 243517, 243519 and 243525 had their mean yields reduced by 3, 5 and 2.5 Bu/A respectively.

PI 226591 and 89784 had no adverse effects due to Mexican bean beetle damage. On the other hand, they seem to possess some mechanism of tolerance as their yields were higher in the non-sprayed plots; thus, apparently the reduction in leaf area brought about by the insects' damage is overcome by the production of either new growth or higher efficiency of the non-damaged tissue. Overall, 89784 had 2.4 Bu/A more in the non-sprayed plots whereas 226591 had 0.5 Bu/A more. PI 80837, the highly resistant strain had no reduction in yield at Poplar Hill and 3 By/A reduction at Snow Hill. On

statistical analysis of the yields and seed size, significant differences were detected at the 1% level of probability in both instances.

Summary

Good sources of resistance have been isolated in maturity groups IV and V. These selections are being used in a crossing program to incorporate resistance into an agronomically desirable variety.

Postemergent Weed Control in Corn

J. V. Parochetti
Department of Agronomy

Purpose and Objectives

Preemergent applications of herbicides for weed control in corn generally results in better grassy weed control and subsequently higher corn yields than postemergent applications. However, growers are sometimes faced with the necessity of treating corn postemergence generally due to unfavorable climatic conditions following corn planting.

The objective of this study was to test combinations of atrazine, dalapon and phytobland oil at reduced rates for giant foxtail control. Another purpose was to evaluate cyprozine (Outfox) pre and postemergence at a short and tall foxtail height, and to evaluate atrazine pre and post-emergence with various mineral vegetable oil combinations.

Procedures

Two field experiments were conducted at the Wye Institute, Queenstown, Maryland. Both experimental sites were located on a Mattapex silt loam. Pioneer 3306 corn was planted on May 12, 1970. Preemergent applications were applied May 3. Early postemergent applications were applied June 4 when corn was 4 to 5 inches tall and in the 5th to 6th leaf stage. Giant foxtail was 1.5 to 2 inches tall and in the 4th to 5th leaf stage. A second post-emergent application was applied June 12 when corn was 15 to 16 inches tall and foxtail was 6 to 8 inches tall. Both experiments were randomized complete blocks with four replications.

Treatments for experiment A are listed in Table 1 and treatments for experiment B are listed in Table 2.

Results

Atrazine + dalapon at 1 + 0.5 lb/A, respectively, was about equally effective whether oil was added or not; fall panicum control was poor, but

foxtail control was good to excellent (70-80%) (Table 1). Atrazine + dalapon at 2 + 1 lb/A, respectively, with oil was fair on fall panicum control being 65% versus only 38% without oil. When atrazine was used alone, fall panicum control was approximately 60% whether oil was used or not. Foxtail control, however, was only 53% with atrazine, 2 lb/A, + oil and 38% without oil.

Doubling the registered rate of atrazine + dalapon, 1 + 0.5 lb/A, did not result in corn injury. Atrazine + dalapon, 1 + 0.5 lb/A, would appear to be more effective postemergence than atrazine, 2 lb/A, + oil. This should be an effective method for reducing the possibility of atrazine residue; 0.5 lb/A of dalapon can effectively substitute for 1 lb/A of atrazine in the combination of dalapon + atrazine postemergence.

Cyprozine preemergence, 1.25 lb/A, resulted in 100% foxtail and fall panicum control (Table 2). Atrazine also resulted in 100% foxtail control, at 2 lb/A preemergence and 95% fall panicum control. Cyprozine, 0.75 lb/A postemergence at 1.5 to 2 inches, resulted in 93% foxtail control and 58% fall panicum control. Cyprozine, 1.5 lb/A, resulted in 98% control of foxtail and fall panicum. Late postemergence treatments were less effective.

Atrazine, 2 lb/A, postemergence, on 1.5 inch high foxtail resulted in fair control (60%) and inferior fall panicum control (35%). Atrazine, 2 lb/A, on foxtail 6 to 8 inches high, resulted in poor grassy weed control. The addition of oil to atrazine did not enhance herbicidal activity on the grassy species. Of the mineral-vegetable oils studied, most were not effective in increasing atrazine herbicidal activity postemergence except Sun oil COTE X70-100 on 1.5 inch high foxtail which resulted in 70% foxtail control, but did not increase the herbicidal effectiveness on fall panicum. All broadleaf weeds were controlled with the herbicides studied. Some corn injury was experienced with cyprozine, but it did not constitute more than 5% injury and did not reduce corn yields.

Summary

Dalapon + atrazine, 1 + 0.5 lb/A + 1 gallon of herbicidal oil post-emergence, resulted in no corn injury and provided excellent broadleaf control. Doubling this rate did not cause any corn injury.

Cyprozine postemergence provided fair foxtail and poor fall panicum control when applied to grassy weeds that were 6 to 8 inches high. Cyprozine postemergence on 1½ to 2 inch tall grassy weeds resulted in excellent foxtail control and excellent fall panicum control at 1.5 lb/A.

Table 1. Postemergent weed control in corn with atrazine and dalapon.

	Treatment	Rate lb/A	1 gal/A Sun oil 11E	%Foxtail[1/] Control 6/29/70	%Fall[1/] Panicum Control 6/29/70	%Pigweed[1/] Control 6/29/70	%Lambs-[1/] quarters Control 6/29/70	%Velvet[1/] leaf Control 6/29/70	Corn Yield Bu/A 9/22/70
1.	Control			0.0	0.0	0	0	0	43.3
2.	Atrazine + Dalapon	1 $\frac{1}{2}$	+	70.0	37.5	100	100	100	83.7
3.	Atrazine + Dalapon	1 $\frac{1}{2}$	-	80.0	35.0	100	100	90	87.0
4.	Atrazine + Dalapon	2 1	+	80.0	65.0	100	100	100	88.9
5.	Atrazine + Dalapon	2 1	-	92.5	37.5	100	100	100	99.8
6.	Atrazine	2	+	52.5	60.0	100	100	100	101.4
7.	Atrazine	2	-	37.5	57.5	100	100	100	88.6

[1/] Percentage based on visual ratings from 0 to 100.

LSD 0.05 = 27.9
LSD 0.01 = 37.3

Table 2. Weed control resulting postemergent herbicides and oils in corn.

	Treatment	Rate lb/A	Time of Application	% CONTROL[1/] Foxtail 6/29/70	Fall Panicum 6/29/70	Pigweed 6/29/70	Lambs-quarters 6/29/70	Velvet leaf 6/29/70	%Corn[1/] Vigor Reduction 6/29/70	Corn Yield Bu/A 9/22/70
1.	Control			0.0	0.0	0	0	0	0	44.3
2.	S-6115 (Outfox)	1.25	pre	100	100	100	100	100	0	110.6
3.	S-6115	2.0	pre	100	100	100	100	100	0	93.0
4.	Atrazine	2.0	pre	100	95	100	100	100	0	93.5
5.	S-6115	0.75	1½-2 inches	92.5	67.5	100	100	92.5	2.5	96.6
6.	S-6115	1.5	1½-2 inches	97.5	97.5	100	100	92.5	2.5	91.4
7.	S-6115	0.75	6-8 inches	45	42.5	100	100	97.5	0	96.6
8.	S-6115	1.5	6-8 inches	67.5	47.5	100	100	97.5	5	79.4
9.	Atrazine	2.0	1½-2 inches	60	35	100	100	100	0	86.9
10.	Atrazine	2.0	6-8 inches	32.5	32.5	100	100	100	0	91.8
11.	Atrazine + Booster Plus Oil	2.0 1 qt/A	1½-2 inches	62.5	45	100	100	100	0	86.6
12.	Atrazine + Booster Plus Oil	2.0 1 qt/A	6-8 inches	45	25	100	100	100	0	77.4
13.	Atrazine + Sun oil EPAR X70-92	2.0 1 qt/A	1½-2 inches	40	50	100	100	100	0	96.8
14.	Atrazine + Sun oil EPAR X70-92	2.0 1 qt/A	6-8 inches	57.5	42.5	100	100	100	0	85.9
15.	Atrazine + Sun oil COTE X70-100	2.0 1 qt/A	1½-2 inches	70	40	100	100	100	0	79.7
16.	Atrazine + Sun oil COTE X70-100	2.0 1 qt/A	6-8 inches	50	40	100	100	95	0	95.8
17.	Atrazine + Sun oil ECOR X70-97	2.0 1 qt/A	1½-2 inches	47.5	40	100	100	97.5	0	81.4
18.	Atrazine + Sun oil ECOR X70-97	2.0 1 qt/A	6-8 inches	50	17.5	100	100	100	2.5	77.3
19.	Atrazine + Sun oil IIE	2.0 1 qt/A	1½-2 inches	62.5	35	100	100	100	0	103.9

1/ Percentage based on visual ratings from 0 to 100.

LSD 0.05 = 24.2
LSD 0.01 = 32.2

Fall Panicum Control in No-Tillage Corn

J. V. Parochetti
Department of Agronomy

Purpose and Objectives

There are a number of herbicides which are used for weed control in conventional tillage of corn. Only the combination paraquat plus atrazine is registered as a tank-mix for use in no-tillage corn. However, there are other residual herbicides which might perform satisfactorily in no-tillage corn. The objective of this experiment was to evaluate 10 herbicides or combinations for weed control in no-tillage corn.

Procedures

Corn was established in 1970 on a Chillum silt loam site heavily infested with fall panicum. Conventional and no-tillage seeding methods were used with a cover crop of rye. A randomized complete block design with four replications was used. Treatments are listed in Table 1. In treatment 1, the rye was plowed under. Treatment 2 was plowed and treated with atrazine, 2 lb/A. In treatment 3, the rye was mechanically removed and corn planted in the stubble, and in treatments 4 through 13, the rye was killed with $\frac{1}{2}$ lb/A paraquat plus 0.05% wetting agent. Weed control was rated on a scale of 0 to 100 with 100 equalling 100% weed destruction. Oil, when used, was Sun oil 11E at 1 gal/A. Plots were 10 x 30 feet with a row width of 2.5 feet. Spray volume was 30 gpa.

Results

Excellent fall panicum control resulted from applications of simazine alone or in combination with atrazine (Table 1). Simazine alone or in combination with atrazine resulted in 95% or better fall panicum control. Most other herbicides, except chlorbromuron, propachlor and atrazine plus oil effected fair to excellent fall panicum control. Rye, which was seeded

for the cover crop in the fall of 1970, was not effected by any of the chemicals applied at planting time.

Early control of fall panicum was good to excellent for many combinations on June 10, 1970, but this control decreased as the season progressed (Table 1). For excellent season-long fall panicum control, simazine or combinations with simazine appear superior. Where residues may be a problem, the following herbicides provided good season-long control: SD 15418, atrazine and atrazine plus alachlor.

Redroot pigweed was a problem weed in 1970 and was controlled by all chemicals except propachlor.

It was interesting to note that atrazine resulted in over 80% fall panicum control under the no-tillage rye mulch. Where the land had been conventionally tilled and treated with atrazine, fall panicum control was poor being about 50% at the end of the season. When the rye was removed from the field and the stubble sprayed with paraquat and atrazine, fall panicum control was intermediate between conventional tillage and no-tillage practices. Observations on farmers' fields using a corn stubble as a cover clearly indicates that atrazine does not provide adequate fall panicum control. A vigorous rye cover crop and dense mulch probably shades the ground preventing favorable conditions for early fall panicum germination. This situation might account for the differential response of fall panicum control under no-tillage mulch and conventional production. Other mulch covers may, indeed, act differently than the rye mulch cover reported here.

Summary

No-tillage corn was planted in a site heavily infested with fall panicum. Excellent fall panicum control resulted from applications of simazine alone or in combination with atrazine.

The following herbicides provided over 80% control at the end of the season: atrazine, atrazine + alachlor and SD 15418. Atrazine applied to bare ground resulted in poor fall panicum control.

Table 1 Fall panicum control in no-tillage corn.

	Treatment[1]	Rate lb/A	Paraquat ½ lb/A	%Fall Panicum Control[2] 6/10/70	9/24/70
1.	Plow and disk	-----	-	10	0 a[3]
2.	Atrazine (plowed)	2	-	78	50 b
3.	Atrazine (cover removed)	2	+	90	60 bc
4.	Atrazine	2	+	93	80 cd
5.	Atrazine + Prometryne	1 + 1	+	98	70 bcd
6.	Alachlor + Atrazine	1.5 + 1	+	95	75 cd
7.	Linuron	1	+	95	73 bcd
8.	Simazine	2	+	100	100 f
9.	Atrazine + Simazine	1 1	+	100	98 ef
10.	Atrazine + Propachlor	1 3	+	83	10 a
11.	Propachlor	5	+	33	0 a
12.	SD 15418	2	+	100	88 de
13.	Chlorbromuron	1.5	+	93	68 bcd

1/ Treatments 4 through 13 planted in a rye mulch.

2/ Weed control was rated on a scale of 0 to 100 with 100 equalling 100% weed control or crop destruction.

3/ Values followed by the same letter are not statistically different at the 5% level of probability using Duncan's Multiple Range Test.

The Effect of Vernolate, Row Width and Cultivation On Soybean Production and Foxtail Control

J. V. Parochetti
Department of Agronomy

Purpose and Objectives

Until recently soybeans have been most successful when planted so that they could be cultivated for weed control. Chemical weed control has opened the possibility of soybean production without cultivation. Yield increases have been reported for many varieties of soybeans where row spacings have been decreased. However, weeds were controlled by hand removal. The purpose of this study was to evaluate soybean yields at row spacings of 30 and 7 inches using vernolate to control weeds. A comparison of vernolate with 1, 2 and 3 cultivations was also studied at the 30 inch row spacing.

Procedures

A field study was conducted at the Wye Institute, Queenstown, Maryland, on a Mattapex silt loam. A randomized complete block with four replications was used. Plots were 10 x 20 feet; 30 gpa was the spray volume. Treatments are listed in Table 1. Vernolate, 3 lb/A, was preplant incorporated with a rotortiller to a depth of 3 inches. Cutler variety soybeans were planted on June 3, 1970.

The cultivation schedule following planting was: treatment 4 at 3, 5 and 7 weeks; treatment 5 at 3 and 5 weeks; and treatment 6 at 3 weeks.

Results

Vernolate caused soybean vigor reduction (Table 1). Height reduction and crinkling of the first two to three leaves decreased with soybean growth, but did not reduce soybean yields (Table 1); similar results have been previously reported.

Best giant foxtail control occurred in the 7 inch row spacings with vernolate (Table 1). This was attributed to the more rapid canopy develop-

ment in the 7 inch rows in comparison to 30 inch rows. Soybean yields for the 7 inch row spacing plus herbicide were not significantly different from the 30 inch row spacing plus herbicide.

Soybean yields in 30 inch rows with 2 cultivations and no herbicide were significantly greater than one cultivation and no herbicide.

There was no significant increase of soybean yields in 30 inch rows with vernolate alone or vernolate plus one cultivation.

Summary

A field study was conducted on the effect of 7 inch row spacing with vernolate and a maximum of 3 cultivations on soybeans in 30 inch row spacing. Vernolate caused soybean height and vigor reduction of 12.5% of the control; however, yields were not reduced. Best giant foxtail control resulted from 7 inch row spacing. Soybean yields for the 7 inch row spacings with vernolate were not significantly different from the 30 inch rows with vernolate. Soybean yields were similar in 30 inch rows with vernolate alone or vernolate plus cultivation. Vernolate with no cultivation gave better foxtail control than 3 cultivations without vernolate. Increasing the number of cultivations without herbicides from one to two times increased soybean yields.

Table 1. The effect of row width, vernolate and cultivation on soybean production.

	Treatment	Row Width (inches)	Herbicide	% Soybean Vigor Reduction 7/14/70 [1]	% Foxtail Control 7/14/70 [2]	Soybeans Bu/A 1970
1.	Control	30	-	0.0	0	15.0 a [3]
2.	No Cultivation	30	+	12.5	89	22.9 bcd
3.	1 Cultivation	30	+	12.5	88	24.6 cd
4.	1 Cultivation	30	-	0	45	22.1 bc
5.	2 Cultivations	30	-	0	73	30.5 d
6.	3 Cultivations	30	-	0	76	26.7 de
7.	No Cultivation	7	-	0	29	19.5 ab
8.	No Cultivation	7	+	12.5	99	26.2 cde

[1] Soybean vigor reduction was rated on a scale of 0 to 100 with 0 equalling no effect and 100 equalling 100% death. A rating of 30 or more is considered unacceptable injury.

[2] Weed control was rated on a scale of 0 to 100 with 100 equalling 100% weed destruction.

[3] Numbers having the same letter are not significant according to Duncan's Multiple Range Test at the 0.05% level of probability.

Preemergence Herbicides and Combinations for Foxtail Control in Corn

J. V. Parochetti
Department of Agronomy

Purpose and Objectives

There are a number of experimental herbicides which are being developed for possible use for foxtail control in corn. The purpose of these studies was to evaluate several of these experimental herbicides alone and in combination with registered herbicides and to evaluate different formulations of (a) chlorbromuron formulated as a 50 and 75% wettable powder and (b) atrazine formulated as either an 80% wettable powder or a flowable liquid.

Procedure

Two experiments were initiated at the Wye Institute, Queenstown, Maryland, on a Mattapex silt loam. Pioneer 3306 corn was planted May 12, 1970. The experimental design was a randomized complete block with four replications.

Experiment A - Preemergent herbicides were applied May 12. Butylate was incorporated between the rows with a garden rotortiller 2 to 3 inches deep. Treatments are listed in Table 1.

Experiment B - Preemergent herbicides were applied May 13, 1970. Treatments are listed in Table 2.

Results

Experiment A - The following combinations provided excellent foxtail control: SD 15418 + alachlor, SD 15418 + butylate, linuron + propachlor, alachlor + chlorbromuron, BAS 2903H + atrazine and cyprozine + alachlor (Table 1). Fair foxtail control was experienced with linuron + alachlor + atrazine.

Cyprozine at 1.5 lb/A, SD 15418 at 2 lb/A, atrazine at 2 lb/A, alachlor at 1 lb/A, butylate at 3 lb/A and linuron at 0.7 lb/A, each alone provided over 90% foxtail control. No corn injury was observed.

Experiment B - All materials provided 90% or better foxtail control except atrazine, 1 lb/A, and propachlor, 3 lb/A (Table 2). There was less than 5% difference in weed control between formulations at a given rate.

The formulation of atrazine, being sold as a liquid called AAtrex 4L (a water dispersible liquid), performed similarly to the 80% wettable powder at a 2 lb/A rate. No corn injury was observed.

Summary

All of the herbicides applied alone resulted in good to excellent foxtail control except SD 15418 at 1 lb/A and propachlor at 1.35 lb/A.

All herbicide combinations tested provided excellent foxtail control except for atrazine at 1 lb/A and propachlor at 3 lb/A. All combinations provided excellent foxtail control except the three way combination of linuron, alachlor and atrazine tested.

None of the herbicides or combinations resulted in corn injury.

Table 1. Foxtail control resulting from certain herbicides and combinations in corn.

	Treatment	Rate lb/A	Time Applied	%Foxtail Control 6/30/70 [1/]	Corn Yield Bu/A 9/22/70
1.	Control			0	107.7
2.	Atrazine (AAtrex)	2.0	pre	100	111.8
3.	SD 15418 (Bladex)	2.0	pre	93	112.5
4.	Chlorbromuron (Maloran) 50W	2.0	pre	88	108.1
5.	BAS 2903H (Basamaize)	4.0	pre	80	118.6
6.	Alachlor (Lasso)	2.0	pre	98	117.5
7.	SD 15418	1.0	pre	100	143.5
	+ Alachlor	+ 1.0	pre		
8.	SD 15418	1.0	pre	100	117.1
	+ Alachlor	+ 1.5	pre		
9.	SD 15418	1.0	pre	90	112.6
	+ Atrazine	+ 1.0	pre		
10.	SD 15418	1.0	incorporated	95	119.0
	+ Butylate (Sutan)	+ 3.0	incorporated		
11.	Linuron (Lorox)	0.7	pre	90	121.9
	+ Propachlor (Ramrod)	+ 1.35	pre		
12.	Alachlor	1.5	pre	98	111.0
	+ Chlorbromuron 50W	+ 1.0	pre		
13.	Alachlor	1.0	pre	100	110.3
	+ Chlorbromuron 50W	+ 1.0	pre		
14.	BAS 2903H	2.5	pre	93	132.6
	+ Atrazine	+ 1.0	pre		
15.	S-6115 (Outfox)	0.5	pre	100	130.3
	+ Alachlor	+ 1.0	pre		
16.	Cyprozine (Outfox)	0.5	pre	80	115.2
17.	Cyprozine	1.5	pre	100	125.6
18.	Alachlor	1.0	pre	100	121.5
19.	Alachlor	1.5	pre	93	120.5
20.	SD 15418	1.0	pre	58	129.5
21.	Butylate	3.0	ppi	100	94.7
22.	Linuron	0.7	pre	93	104.9
23.	Propachlor	1.35	pre	68	116.9
24.	Chlorbromuron	1.0	pre	83	106.1
25.	Atrazine	1.0	pre	80	115.7
26.	BAS 2903H	2.5	pre	85	116.5
27.	Linuron	0.33	pre	73	118.1
	+ Alachlor	+ 0.7	pre		
	+ Atrazine	+ 1.0	pre		
28.	Linuron	0.7	pre	95	117.5
29.	Alachlor	0.7	pre	95	117.5

[1/] Percentage based on visual ratings from 0 to 100.

LSD 0.05 = 25.3
LSD 0.01 = 33.7

Table 2. Foxtail control resulting from certain preemergent corn herbicide combinations.

	Treatment	Rate lb/A	Time Applied	%Foxtail[1/] Control 6/30/70	Corn Yield Bu/A 9/22/70
1.	Control			0	103.0
2.	Atrazine 80% WP	2.0	pre	100	122.1
3.	Chlorbromuron 50% WP	1.5	pre	95	123.9
4.	Chlorbromuron 50% WP	3.0	pre	100	139.0
5.	Chlorbromuron 75% WP	1.5	pre	95	125.5
6.	Chlorbromuron 75% WP	3.0	pre	100	108.9
7.	Atrazine 4L (flowable liquid)	2.0	pre	97.5	132.2
8.	Alachlor	1.5	pre	97.5	127.2
9.	Atrazine 80% WP	1.0	pre	85	136.1
10.	Atrazine + Alachlor (flowable liquid)	1.0 + 1.5	pre	100	117.1
11.	Atrazine 80% WP + Alachlor (tank-mix)	1.0 +	pre	100	120.5
12.	Propachlor 65% WP	3.0	pre	87.5	118.3
13.	Atrazine 80% WP + Propachlor 65% WP (tank-mix)	1.0 + 3.0	pre	95	136.2
14.	Atrazine + Propachlor (granular)	1.0 + 3.0	pre	100	138.3
15.	Dinoseb + Propachlor (granular)	1.5 +	pre	90	103.8
16.	Dinoseb + Propachlor (granular)	3.0 + 6.0	pre	100	103.0

[1/] Percentage based on visual ratings from 0 to 100.

LSD 0.05 = 16.9
LSD 0.01 = 22.6

Postdirected and Split Applications of Herbicides for Weed Control in Soybeans

J. V. Parochetti
Department of Agronomy

Purpose and Objectives

The large-seeded broadleaved weeds, such as morningglory and jimsonweed and occasionally cocklebur, are becoming increasingly troublesome in soybean culture. No herbicides, preemergence or at cracking, provide satisfactory control of these large-seeded broadleaved weeds for the entire season. Combinations of herbicides applied at different stages of soybean growth should provide better weed control of these troublesome species than a single herbicide application.

The purpose of these particular experiments were to evaluate several herbicides preplant incorporated or preemergence, alone and in combination with chloroxuron. Chloroxuron was also studied postemergence alone. Another objective was to evaluate several herbicides at or before planting for early grass and broadleaf weed control followed by a postdirected application of 2,4-DB or dinoseb when soybeans were 7 to 9 inches tall.

Procedure

Two experimental sites were established at the Wye Institute, Queenstown, Maryland; both on a Mattapex silt loam. Cutler soybeans were planted June 3, 1970, on both sites, preplant incorporated and preemergence herbicides were applied June 3. Herbicides were incorporated with a garden tractor mounted rotortiller 2 to 3 inches deep. The "at cracking" treatments were applied June 9, the "post overall" treatments were applied June 30 when soybeans had two trifoliate leaves. The "postdirected" treatments were applied July 15 when soybeans were approximately 9 inches tall.

The experimental design in both experiments was a randomized complete block with four replications.

Treatments are listed in Table 1 for experiment A and treatments for experiment B are listed in Table 2.

Results

Experiment A - The following herbicides applied preplant incorporated or preemergence alone and in combination with chloroxuron postemergence provided excellent foxtail and crabgrass control: trifluralin, nitralin, vernolate, linuron, alachlor and fluorodifen (Table 1). Chloroxuron alone postemergence was not effective in controlling giant foxtail and crabgrass. However, it provided 100% pigweed control. The other herbicides applied alone as a preplant incorporated or preemergent treatment also were very effective on pigweed.

Soybean vigor was reduced with chloroxuron postemergence alone. Vigor reduction was approximately 12.5% compared to the control. Vernolate did cause some soybean vigor reduction. Vigor reduction decreased as the season advanced (Table 1). Combining vernolate with chloroxuron resulted in the most soybean vigor reduction noted being approximately 33%. Although yields were not significantly lowered by the severe vigor reduction, there was a trend towards lower yields. Chloroxuron alone postemergence resulted in yields which were comparable to the uncultivated control because of the lack of adequate annual grassy weed control.

Experiment B - Dinoseb alone postdirected at 1.5 and 3 lb/A and alachlor (1.0 lb/A) + dinoseb (1.5 lb/A) at cracking plus dinoseb (3 lb/A) postdirected were the only treatments which did not statistically reduce the morningglory population (Table 2). For jimsonweed, the following treatments were not different from the uncultivated check: vernolate at 3 lb/A ppi, 2,4-DB at 0.2 lb/A postdirected, 2,4-DB at 0.4 lb/A postdirected, dinoseb at

1.5 lb/A postdirected and alachlor (1.0 lb/A) + dinoseb (1.5 lb/A) at cracking + 2,4-DB (0.4 lb/A) postdirected.

Weeds and soybeans were harvested together and the weight per plot of morningglory and jimsonweed seed recorded. Only dinoseb, 1.5 lb/A postdirected, was similar to the uncultivated check; vernolate, 3 lb/A, preplant incorporated, resulted in a significantly greater yield of morningglory seed than the uncultivated check. All soybean yields were significantly greater than the uncultivated check except dinoseb, 1.5 lb/A postdirected, and vernolate, 3 lb/A preplant incorporated.

One of the better treatments in this study was fluorodifen (1.5 lb/A) + dinoseb (1.5 lb/A) at cracking plus either 2,4-DB postdirected (0.4 lb/A) or dinoseb (1.5 lb/A) postdirected.

Summary

Chloroxuron applied as a postemergent treatment to soybeans having two trifoliate leaves controlled broadleaved weeds, but not grassy weeds. Trifluralin, nitralin, vernolate, linuron, chlorbromuron and fluorodifen provided annual grassy weed control; combinations of any one of these herbicides plus chloroxuron did not result in a significant yield reduction of soybeans.

Where large-seeded problem broadleaved weeds such as morningglory and jimsonweed are a problem, they are generally associated with annual grassy weeds. Herbicides such as 2,4-DB or dinoseb which are applied postdirected are not effective on annual grassy weeds. An effective at cracking treatment was fluorodifen + dinoseb which provided excellent annual grassy weed control and temporary morningglory and jimsonweed control. The treatment also provided a height differential enabling the effective application of a postdirected spray.

Table 1. The effect of herbicides and split application combinations on weed control and soybean growth and yields.

	Treatment	Rate lb/A	Time Applied	%Foxtail[1] Control 7/14/70	%Pigweed[1] Control 7/14/70	%Crabgrass[1] Control 7/14/70	Soybean Vigor Reduction 7/14/70	Soybean Vigor Reduction 7/25/70	Soybean Yield Bu/A 10/14/70
1.	Control	----	----	0	0	0	0	7.5	5.6
2.	Trifluralin (Treflan)	0.75	ppi	85	10	100	2.5	0	22.6
3.	Nitralin (Planavin)	0.75	ppi	87.5	92.5	100	0	0	18.6
4.	Vernolate (Vernam)	3.0	ppi	92.5	97.5	97.5	2.5	5	22.4
5.	Linuron (Lorox)	1.0	pre	97.5	10	95	0	0	16.8
6.	Alachlor (Lasso)	1.5	pre	95	97.5	95	2.5	2.5	18.4
7.	Fluorodifen (C-6989)	3.0	pre	90	97.5	95	0	0	13.7
8.	Chlorbromuron	2.0	pre	92.5	92.5	95	0	2.5	20.5
9.	Chloroxuron (Tenoran) + ½% Adjuvan-T	1.5	post post	35	10	50	12.5	10	13.9
10.	Chloroxuron + ½% Adjuvan-T	3.0	post post	0	10	0	12.5	0	7.7
11.	Trifluralin + Chloroxuron + Adjuvan-T (½%)	0.75 1.5	ppi post	97.5	10	100	17.5	10	19.9
12.	Nitralin + Chloroxuron + Adjuvan-T (½%)	0.75 1.5	ppi post	87.5	10	97.5	17.5	10	21.2
13.	Vernolate + Chloroxuron + Adjuvan-T (½%)	3.0 1.5	ppi post	95	10	100	32.5	25	17.4
14.	Linuron + Chloroxuron + Adjuvan-T (½%)	1.0 1.5	pre post	92.5	10	97.5	15	15	20.4
15.	Alachlor + Chloroxuron + Adjuvan-T (½%)	1.5 1.5	pre post	95	10	97.5	15	10	18.8
16.	Fluorodifen + Chloroxuron + Adjuvan-T (½%)	3.0 1.5	pre post	95	10	97.5	17.5	10	20.2
17.	Chlorbromuron Chloroxuron + Adjuvan-T (½%)	2.0 1.5	pre post	97.5	10	100	17.5	15	20.9

[1] Percentage based on visual ratings from 0 to 100.

LSD 0.05 = 6.3
LSD 0.01 = 8.5

Table 2. Morningglory and jimsonweed control with herbicides; combination and postdirected herbicides in soybeans.

	Treatment	Rate lb/A	Time Applied	Morningglory[2] Next to row 38 sq. ft. 8/5/70	Jimsonweed[2] Next to row 38 sq. ft. 8/5/70	Small Morningglory[2] Middle of row 44 sq. ft. 8/5/70	Soybean[1] Vigor Reduction 7/25/70	Harvested Morningglory and Jimsonweed seeds (grams/plots) 10/20/70	Soybean Yields Bu/A 10/20/70
1.	Control			31.0 g	26.0 d	0 a	2.5	71.64 c	12.7 a
2.	Control Cultivated			16.50 cde	7.25 abc	9.0 abc	0	34.09 ab	24.9 c-g
3.	Vernolate (Vernam)	3.0	ppi	10.75 a-e	16.50 a-d	0.25 a	2.5	100.24 d	20.0 abc
4.	Dinoseb (Premerge)	3.0	AC[3]	7.5 abc	1.25 a	1.25 a	0	9.33 a	31.5 fg
5.	Alachlor (Lasso) +	1.0	AC	14.0 a-f	4.25 abc	5.50 abc	0	33.85 ab	28.6 c-g
	Dinoseb	1.5	AC						
6.	Fluorodifen (C-6989) +	1.5	AC	11.0 a-e	3.25 abc	3.25 ab	0	24.61 ab	28.1 c-g
	Dinoseb	1.5	AC[4]						
7.	2,4-DB (Butyrac 175)	0.2	PD	16.0 b-f	17.25 a-d	24.75 a-e	2.5	7.71 a	21.4 bcd
8.	2,4-DB	0.4	PD	10.75 a-e	20.75 cd	18.50 a-d	0	7.03 a	22.1 b-e
9.	Dinoseb	1.5	PD	26.25 fg	11.50 a-d	14.50 a-d	5.0	50.33 bc	16.4 ab
10.	Dinoseb	3.0	PD	22.0 d-g	2.25 a	14.50 a-d	0	32.09 ab	21.8 bcd
11.	Vernolate +	3.0	ppi	4.50 abc	6.50 abc	23.25 a-e	10	6.46 a	26.8 c-g
	2,4-DB	0.2	PD						
12.	Dinoseb +	3.0	AC	9.25 a-d	2.75 ab	17.75 a-d	2.5	3.77 a	24.1 b-f
	2,4-DB	0.2	PD						
13.	Alachlor +	1.0	AC	8.75 a-d	0.25 a	30.75 a-e	0	2.92 a	26.9 c-g
	Dinoseb +	1.5	AC						
	2,4-DB	0.2	PD						
14.	Fluorodifen +	1.5	AC	10.75 a-e	1.0 a	37.75 cde	0	2.97 a	27.5 c-g
	Dinoseb +	1.5	AC						
	2,4-DB	0.2	PD						
15.	Vernolate +	3.0	ppi	6.50 abc	1.0 a	26.50 a-e	17.5	18.79 a	25.6 c-g
	2,4-DB	0.4	PD						
16.	Dinoseb +	3.0	AC	6.25 abc	1.25 a	35.25 b-e	2.5	.56 a	32.0 fg
	2,4-DB	0.4	PD						
17.	Alachlor +	1.0	AC	8.75 a-d	20.25 bcd	31.50 a-e	5.0	10.63 a	26.2 c-g
	Dinoseb +	1.5	AC						
	2,4-DB	0.4	PD						

Table 2 (contd.)

	Treatment	Rate lb/A	Time Applied	Morningglory[2] Next to row 38 sq. ft. 8/5/70	Jimsonweed[2] Next to row 38 sq. ft. 8/5/70	Small Morningglory[2] Middle of row 44 sq. ft. 8/5/70	Soybean[1] Vigor Reduction 7/25/70	Harvested Morningglory and Jimsonweed seeds (grams/plots) 10/20/70	Soybean Yields Bu/A 10/20/70
18.	Fluorodifen +	1.5	AC	2.50 ab	2.50 a	22.50 a-e	2.5	1.64 a	27.5 c-g
	Dinoseb +	1.5	AC						
	2,4-DB	0.4	PD						
19.	Vernolate +	3.0	ppi	9.0 a-d	0.0 a	12.0 abc	5.0	15.91 a	27.5 c-g
	Dinoseb	1.5	PD						
20.	Dinoseb +	3.0	AC	15.25 a-f	0.0 a	23.25 a-e	0	15.93 a	25.4 c-g
	Dinoseb	1.5	PD						
21.	Alachlor +	1.0	AC	17.0 c-f	0.0 a	46.75 de	0	15.91 a	27.5 c-g
	Dinoseb +	1.5	AC						
	Dinoseb	1.5	PD						
22.	Fluorodifen +	1.5	AC	2.25 a	0.25 a	16.75 a-d	5.0	6.05 a	33.3 g
	Dinoseb +	1.5	AC						
	Dinoseb	1.5	PD						
23.	Vernolate +	3.0	ppi	12.50 a-e	0.25 a	26.50 a-e	2.5	6.05 a	29.5 d-g
	Dinoseb	3.0	PD						
24.	Dinoseb +	3.0	AC	13.50 a-f	0.25 a	31.50 a-e	0	6.49 a	30.8 efg
	Dinoseb	3.0	PD						
25.	Alachlor +	1.0	AC	23.50 efg	0.25 a	54.75 e	0	12.65 a	30.7 efg
	Dinoseb +	1.5	AC						
	Dinoseb	3.0	PD						
26.	Fluorodifen +	1.5	AC	4.25 abc	0.25 a	23.25 a-e	5.0	3.89 a	29.2 d-g
	Dinoseb +	1.5	AC						
	Dinoseb	3.0	PD						

1/ Percentage based on visual ratings from 0 to 100.

2/ Values followed by the same letter are not statistically different at the 5% level of probability using Duncan's Multiple Range Test.

3/ AC - At Cracking.

4/ PD - Postdirected applied on cultivator shank; therefore, all PD plots were cultivated; all other plots were not cultivated except the control cultivated.

Johnsongrass Control in Soybeans

J. V. Parochetti
Department of Agronomy

Purpose and Objectives

Johnsongrass is a serious pest in Maryland, especially on the Eastern Shore. This noxious weed, once it has infested a small portion of a field, can spread if not contained by chemical or cultural control methods. A portion of an infested field at the Wye Institute, Queenstown, Maryland, was chosen as a site for johnsongrass control in soybean culture. In order to evaluate different control measures, an experiment consisting of 11 treatments, which was initiated in 1969, was continued on the same location in 1970.

Procedures

Herbicide treatments were applied to the same site in 1970 as had been applied in 1969. Treatments are listed in Table 1. Preplow foliar applications of dalapon were applied June 4 to actively growing johnsongrass. Preplant incorporated (ppi) herbicides were applied June 17; soybeans were planted June 18, but because of the poor stand, were disked and replanted June 24. The experimental design was a randomized complete block with three replications. Plot size was 15 x 40 feet with half of the plots being cultivated.

Results

The best treatment in 1970 was dalapon plus trifluralin and one cultivation. This combination effected 99.7% control (Table 1). One cultivation and dalapon plus nitralin or dalapon plus vernolate resulted in 97.3% and 99.5% johnsongrass control. One cultivation increased johnsongrass control. When the land was tilled eight separate times before incorporating the herbicides trifluralin and nitralin, excellent johnsongrass control resulted being 98 and 97% control, respectively. The use of dalapon alone plus cultivation effected excellent control.

Summary

In soybean production, best johnsongrass control resulted from a combination of cultivation and a split application of dalapon applied to foliar johnsongrass with either trifluralin, nitralin and vernolate applied preplant incorporated.

Table 1. The influence of herbicides and cultivation on the control of johnsongrass and the yield of soybeans.

	Treatment	Rate lb/A	Time of Application	% Johnsongrass Control[1/] 9/10/70			Soybean Yields (Bu/A)		
				Cult.	Not Cult.	Average	Cult.	Not Cult.	Average
1.	Control			72.6 cde	.0 a	36.3 a	5.6 abc	4.8 ab	5.2 a
2.	Dalapon + ½% Adjuvan-T	5.0	preplow	94.4 efg	74.8 cde	84.6 de	14.1 d-h	7.9 a-d	11.0 ab
3.	Trifluralin	1.0	ppi	83.2 d-g	34.2 b	58.7 bc	15.7 d-i	11.0 a-f	13.4 b
4.	Nitralin	1.0	ppi	82.9 d-g	26.2 b	54.5 b	12.4 b-g	6.1 abc	9.3 ab
5.	Vernolate	3.0	ppi	69.3 cd	5.4 a	37.4 a	5.5 abc	3.2 a	4.4 a
6.	Dalapon + Trifluralin + ½% Adjuvan-T	5.0 + 1.0	preplow ppi	99.7 g	83.3 d-g	91.5 e	25.9 jkl	17.7 e-i	21.8 de
7.	Dalapon + Nitralin + ½% Adjuvan-T	5.0 + 1.0	preplow ppi	97.3 fg	85.5 d-g	91.4 e	26.1 kl	19.8 g-k	22.9 de
8.	Dalapon + Vernolate + ½% Adjuvan-T	5.0 + 3.0	preplow ppi	99.5 g	79.3 d-g	89.4 e	18.1 f-j	12.8 c-g	15.5 bcd
9.	Trifluralin (8 prior tillages)	1.0	ppi	98.0 fg	76.1 def	87.0 e	28.0 l	21.1 h-l	24.6 e
10.	Nitralin (8 prior tillages)	1.0	ppi	97.0 fg	74.6 cde	85.8 e	23.0 i-l	18.8 f-k	20.9 cde
11.	Vernolate (8 prior tillages)	3.0	ppi	86.5 d-g	54.6 c	70.5 cd	17.7 e-i	9.9 a-e	13.8 bc
	TOTAL AVERAGE			89.1	54.0		17.5	12.1	

1/ % Control was calculated by the following formula: $\frac{100 \times \text{fresh weight plot}}{\text{fresh weight of control, uncultivated}}$
Plots were harvested September 10, 1970

Yellow Nutsedge and Fall Panicum Control in Corn

J. V. Parochetti
Department of Agronomy

Purpose and Objectives

Yellow nutsedge and fall panicum have been troublesome weeds in corn production in Maryland during the last several years. Research in the past few years at the University of Maryland has shown that butylate, alachlor and atrazine are effective when using combinations for yellow nutsedge control. Alachlor and butylate are effective for fall panicum, but atrazine applications have not consistently controlled fall panicum. The purpose of this research was to continue research with alachlor, butylate and atrazine for fall panicum and nutsedge control.

Procedures

An experimental area heavily infested with yellow nutsedge was chosen at the Wye Institute, Queenstown, Maryland. Pioneer 3369A corn was planted on May 21, 1970. Preplant incorporated herbicides (ppi) were applied May 21 and incorporated with a garden tractor mounted rotortiller 2 to 3 inches deep. Preemergent herbicides were applied May 21 and postemergent applications were made June 12 when annual grassy weeds were approximately 2 inches tall and yellow nutsedge approximately 1 inch tall. The experimental design was a randomized complete block with four replications and the soil type was a Mattapex silt loam.

Results

Nutsedge control was best with combinations of butylate + atrazine, 3 + 1 lb/A, respectively, or atrazine preplant incorporated (ppi), 2 lb/A + atrazine postemergence (post), 1 or 2 lb/A (Table 1).

Butylate at 2 lb/A ppi resulted in fair to good nutsedge control (75 to 80%) at mid-season (July 25). Alachlor ppi at 2 lb/A resulted in 80% nutsedge control on July 25 and alachlor at the 4 lb/A rate resulted in 90% control.

Fall panicum was controlled by alachlor at all rates. Butylate alone or in combination with atrazine provided good to excellent fall panicum control. Atrazine provided good to excellent fall panicum control ppi at rates of 2 lb/A or higher. The postemergent application rates without oil were not effective on fall panicum. However, atrazine at 4 lb/A with oil did provide satisfactory fall panicum control.

Summary

Combinations of butylate ppi plus atrazine post or atrazine ppi plus atrazine post provided better yellow nutsedge control than the application of these herbicides applied only as ppi. Alachlor at 4 lb/A ppi provided excellent nutsedge control.

Fall panicum control was excellent with butylate and alachlor at all rates. Atrazine provided fall panicum control at 2 lb/A or higher ppi and pre, but only at 4 lb/A post plus oil.

Table 1. Yellow nutsedge, foxtail and fall panicum control in corn.

	Treatment	Rate lb/A	Time of Application	Oil	%Nutsedge Control 6/29/70 [1/]	%Nutsedge Control 7/25/70 [1/]	%Foxtail Control 7/25/70 [1/]	%Fall Panicum Control 7/25/70	Corn Bu/A 9/22/70 [2/]
1.	Control				0	0	45	5	69.9 a
2.	Atrazine	1.0	ppi	no	32.5	27.5	72.5	57.5	89.9 ab
3.	Atrazine	2.0	ppi	no	72.5	80	95	85	110.7 b
4.	Atrazine	4.0	ppi	no	72.5	82.5	97.5	90	88.3 ab
5.	Atrazine	2.0	pre	no	75	82.5	92.5	90	99.2 ab
6.	Atrazine	4.0	pre	no	65	72.5	97.5	97.5	113.2 b
7.	Atrazine	1.0	post	no	72.5	50	47.5	32.5	92.1 ab
8.	Atrazine	2.0	post	no	75	42.5	72.5	42.5	83.8 ab
9.	Atrazine	4.0	post	no	92.5	87.5	85	55	92.9 ab
10.	Atrazine	1.0	post	yes	52.5	35	62.5	37.5	100.8 ab
11.	Atrazine	2.0	post	yes	92.5	45	75	22.5	99.2 ab
12.	Atrazine	4.0	post	yes	87.5	80	87.5	85	102.6 ab
13.	Atrazine +	2.0	ppi	no	62.5	90	100	72.5	103.2 ab
	Atrazine	2.0	pre	no					
14.	Atrazine +	2.0	ppi	no	75	85	95	92.5	96.9 ab
	Atrazine	2.0	post	no					
15.	Atrazine +	2.0	ppi	no	77.5	80	100	90	88.2 ab
	Atrazine	2.0	post	yes					
16.	Atrazine +	2.0	ppi	no	82.5	90	97.5	92.5	93.4 ab
	Atrazine	1.0	post	yes					
17.	Atrazine +	2.0	ppi	no	62.5	80	97.5	85	79.2 ab
	Atrazine	1.0	post	no					
18.	Atrazine +	1.0	ppi	no	75	77.5	100	100	102.7 ab
	Butylate	3.0	ppi	no					
19.	Atrazine +	1.0	post	no	70	82.5	97.5	95	109.7 b
	Butylate	3.0	ppi	no					
20.	Atrazine +	1.0	post	yes	70	80	97.5	72.5	99.6 ab
	Butylate	3.0	ppi	no					
21.	Atrazine +	1.0	ppi	no	75	80	97.5	97.5	99.9 ab
	Butylate	4.0	ppi	no					

Table 1. (contd.)

	Treatment	Rate lb/A	Time of Application	Oil	%Nutsedge[1] Control 6/29/70	%Nutsedge[1] Control 7/25/70	%Foxtail[1] Control 7/25/70	%Fall Panicum[1] Control 7/25/70	Corn[2] Bu/A 9/22/70
22.	Atrazine +	2.0	ppi	no	72.5	72.5	100	100	86.3 ab
	Butylate	3.0	ppi	no					
23.	Atrazine +	2.0	ppi	no	77.5	87.5	100	100	104.0 ab
	Butylate	4.0	ppi	no					
24.	Atrazine	2.0	ppi	no	60	62.5	100	97.5	104.4 ab
25.	Alachlor	1.5	ppi	no	75	72.5	92.5	95	113.1 b
26.	Alachlor	2.0	ppi	no	77.5	80	97.5	97.5	88.6 ab
27.	Alachlor	4.0	ppi	no	95	90	100	100	108.5 b
28.	Control Cultivated				12.5	80	25	67.5	103.5 ab
29.	Butylate	2.0	ppi	no	72.5	75	100	97.5	78.1 ab
30.	Butylate	3.0	ppi	no	67.5	80	100	97.5	71.0 a
31.	Butylate	4.0	ppi	no	62.5	80	100	72.5	99.5 ab

1/ Percentage based on visual ratings from 0 to 100.

2/ Numbers having the same letter are not statistically different at the 5% level of probability according to Duncan's Multiple Range Test.

Weed Control in Tobacco

J. V. Parochetti
Department of Agronomy

Purpose and Objectives

Three herbicides are currently registered for weed control in Maryland tobacco. These herbicides are diphenamid, benefin and pebulate. Diphenamid has been registered for a number of years for post transplant applications, and the other two herbicides, benefin and pebulate, have recently been registered as preplant incorporated herbicides. Maryland tobacco growers have been reluctant to use herbicides. They have relied heavily on timely cultivations for adequate weed control, but with greater demands on the growers' time and less labor available to perform timely cultivations, it has become necessary for many growers to use herbicides as a substitute for early cultivation.

The purpose of these studies was to evaluate several herbicides in tobacco production with and without cultivation and to evaluate cultivations alone for weed control.

Procedure

An experimental site was located on the Tobacco Research Farm, Upper Marlboro, Maryland, on a Monmouth fine sandy loam. Maryland tobacco 609 was planted June 9, 1970. Preplant incorporated herbicides were applied June 9 before transplanting and postemergent herbicides were applied June 9 after transplanting.

The experimental design was a randomized complete block with four replications. Rototilling was accomplished by using a garden mounted rototiller which worked the soil two to three inches deep. Plot size was 10 x 25 feet.

Results

The weed infestation on this site was sparse. All treatments without cultivation generally provided good to excellent weed control except diphenamid

which was particularly weak on lambsquarters at both rates studied and nitralin at 1 lb/A preplant incorporated. Vernolate, preplant incorporated, without cultivation caused 27.5% tobacco vigor reduction as compared to 17.5% injury with vernolate plus cultivation.

A mixture of barley and wheat was seeded in the plots in October and an estimated stand reduction was taken December 7. Nitralin at 2 lb/A with cultivation resulted in 25% stand reduction; when a similar treatment was not cultivated, the reduction was even higher being 45%. Nitralin at 1 lb/A without cultivation resulted in 30% grain kill and with cultivation 10%. Benefin at 2.5 lb/A without cultivation resulted in 25% stand reduction, whereas the similar treatment with cultivation resulted in only 10% stand reduction.

Herbicides, with and without cultivation, provided good to excellent goosegrass control. Diphenamid and nitralin at 1 lb/A did not effect satisfactory lambsquarters control, without cultivation. There was a significant difference in the dollar/A ($/A) data on harvested tobacco and a significant reduction of lb/A of tobacco with uncultivated diphenamid (2 lb/A).

Summary

Diphenamid, benefin and pebulate, with and without cultivation, resulted in good to excellent goosegrass control. However, lambsquarters control was not satisfactory with diphenamid or nitralin (1 lb/A) unless supplemented with cultivation. Because of the weeds present in the uncultivated diphenamid, the dollar/A return and the lb/A of tobacco was significantly reduced; all our chemical treatments did not reduce the quality or quantity of harvested tobacco.

Table 1. The effect of herbicides and cultivation on weed control and tobacco.

	Treatment	Rate lb/A	Cult.	% Control Pigweed 7/22/70	% Control Lambs-quarters 7/22/70	% Control Goose-grass 7/22/70	% Stand Reduction 7/22/70 [a/]	% Tobacco Vigor Reduction 7/22/70	Tobacco Harvest Data lb/A	$/A	$/cwt
1.	Control-Not Cultivated	----	----	0	0	25	1.0	0	932.80 a	660.95 a	69.34
2.	Cultivated 3 times	----	----	93	93	93	0	0	1596.17 c	1153.35 d	71.78
3.	Cultivated 2 times	----	----	90	90	98	8	0	1688.17 c	1252.52 d	74.15
4.	Cultivated 2 times	----	----	98	98	95	5	0	1649.22 c	1197.97 d	72.12
5.	Diphenamid (Enide 50W)	2	yes	95	93	98	10	0	1484.30 bc	1055.74 bcd	70.62
6.	Cultivated 1 time	----	----	93	80	90	10	0	1603.62 c	1166.61 d	72.06
7.	Diphenamid (Enide 50W)	4	yes	98	95	98	10	0	1792.57 c	1292.35 d	72.16
8.	Nitralin (Planavin)	1.0	yes	100	98	100	10	0	1686.52 c	1226.73 d	72.63
9.	Nitralin (Planavin)	2.0	yes	100	100	100	25	13	1629.30 c	1172.45 d	71.71
10.	Benefin (Balan)	1.12	yes	100	100	100	3	3	1715.47 c	1239.44 d	72.03
11.	Benefin (Balan)	2.25	yes	100	100	100	10	0	1739.57 c	1263.28 d	72.53
12.	Pebulate (Tillam)	2.0	yes	100	100	100	1	3	1654.20 c	1176.57 d	71.16
13.	Pebulate (Tillam)	4.0	yes	100	100	100	1	5	1870.47 c	1333.65 d	71.39
14.	Pebulate (Tillam)	6.0	yes	100	100	100	0	5	1768.55 c	1262.86 d	71.10
15.	Vernolate (Vernam)	3.0	yes	100	100	100	5	18	1889.67 c	1374.28 d	72.69
16.	Diphenamid	2.0	no	70	18	80	15	0	1096.45 a	777.80 ab	69.21
17.	Diphenamid	4.0	no	100	28	93	15	0	1174.37 c	841.97 abc	70.50
18.	Nitralin	1.0	no	88	38	85	3	0	1548.95 c	1107.62 cd	71.50
19.	Nitralin	2.0	no	98	80	93	45	3	1664.95 c	1225.64 d	73.59
20.	Benefin	1.12	no	100	80	90	18	3	1751.15 c	1267.19 d	72.20
21.	Benefin	2.25	no	100	93	95	25	0	1789.27 c	1289.13 d	72.01
22.	Pebulate	2.0	no	100	70	95	18	0	1770.20 c	1283.58 d	72.50
23.	Pebulate	4.0	no	100	83	95	13	8	1837.35 c	1340.46 d	72.94
24.	Pebulate	6.0	no	100	95	100	13	8	1698.15 c	1208.85 d	71.17
25.	Vernolate	3.0	no	100	100	100	15	28	1855.30 c	1316.12 d	70.86

[a/] A mixture of barley and wheat was drilled into the experimental site in October after disking the land. n.s.

An Anidote for EPTC and Butylate Injury on Corn

J. V. Parochetti
Department of Agronomy

Purpose and Objectives

In 1969, a seed treatment of 1,8 napthalic anhydride (NA) at 0.5% by weight prevented EPTC and butylate injury to corn. The purpose of this study was to evaluate the effectiveness of NA as an anidote for EPTC and butylate injury on corn and to establish a rate at which EPTC and butylate injured corn.

Procedure

An experimental field site was chosen at the Wye Institute, Queenstown, Maryland, on a Mattapex silt loam. Pioneer 3369A corn was planted May 21, 1970. Herbicides were incorporated on May 21 with a garden tractor mounted rotortiller 2 to 3 inches deep. The experimental design was a randomized complete block with four replications.

Results

EPTC at 3 lb/A preplant incorporated (ppi) did not result in a significant increase in corn injury over the control (Table 1). There was a significant increase in corn injury with EPTC at 6 and 9 lb/A ppi. Corn treated with 0.5% NA was not injured by any rates of EPTC.

There was no significant increase in corn injury at 16 lb/A butylate. There was no statistical reduction in corn yields when compared to the control although there was a trend for untreated corn in EPTC plots to be lower. Only untreated seed corn planted in 9 lb/A of EPTC resulted in a significant height reduction when measured on July 21.

Summary

Butylate did cause some corn injury on untreated seed corn. However, even at 4 times the recommended rate, which is 16 lb/A, only approximately 10% of the corn population was injured. In contrast, EPTC at 6 and 9 lb/A caused excessive corn injury. Treating the seed corn with a 0.5% 1,8 napthalic anhydride was effective in eliminating injury to corn from EPTC and butylate.

Table 1. The influence of 1,8 napthalic anhydride plus EPTC or butylate on the growth and yield of corn.

	Treatment	Rate lb/A	Time of Application	Seed	No. of Corn Injured Plants[1] Center two rows 6/9/70	Corn Heights in Centimeters 7/21/70	Corn Bu/A 9/22/70
1.	Control	----	----	Untreated	0 a[2]	187.5 bc[2]	85.4 ab[2]
2.	EPTC (Eptam)	3	ppi	Untreated	12 a	200.8 c	97.8 ab
3.	EPTC	6	ppi	Untreated	43 b	153.8 ab	86.8 ab
4.	EPTC	9	ppi	Untreated	54 b	118.3 a	69.7 a
5.	EPTC	3	ppi	Treated[3]	0 a	193.3 bc	110.0 b
6.	EPTC	6	ppi	Treated	3 a	202.8 c	106.5 b
7.	EPTC	9	ppi	Treated	2 a	182.0 bc	97.1 ab
8.	Butylate	4	ppi	Untreated	2 a	212.0 c	108.7 b
9.	Butylate	8	ppi	Untreated	2 a	199.0 c	95.7 ab
10.	Butylate	16	ppi	Untreated	7 a	202.5 c	100.5 c
11.	Butylate	4	ppi	Treated	0 a	198.8 c	109.8 b
12.	Butylate	8	ppi	Treated	0 a	210.0 c	94.6 ab
13.	Butylate	16	ppi	Treated	0 a	204.5 c	90.1 ab

1/ Total of 72 corn plants in center two rows.

2/ Numbers followed by the same letter are not statistically different at the 5% level of probability according to Duncan's Multiple Range Test.

3/ Treated with 0.5% 1,8 napthalic anhydride.

Soybean Herbicides Applied at Different Growth Stages of Soybeans

J. V. Parochetti
Department of Agronomy

Purpose and Objectives

Many herbicides are applied as soybeans emerge (at cracking). Considerable injury can occur with certain herbicides applied after the soybeans have fully emerged from the ground. Recently registered herbicides may be applied at cracking. The purpose of this study was to evaluate several registered and experimental herbicides for weed control in soybeans and to evaluate these herbicides preemergence, at cracking or postemergence (in the cotyledonary to first leaf stage) in soybeans.

Procedure

A field study was established at the Poplar Hill Research Farm near Salisbury, Maryland, on a Bertie silt loam. York variety soybeans were planted June 8, 1970. Preemergence herbicides were applied June 8. Herbicides were applied at cracking on June 16. Postemergent applications were made June 23 when soybeans were in the cotyledonary to first true leaf; grassy weeds were approximately 1.5 inches tall. The experimental design was a randomized complete block with four replications.

Results

Amiben + dinoseb, preemergence or at cracking, resulted in excellent crabgrass control (Table 1). Alachlor + dinoseb, preemergence and at cracking, also effected good to excellent crabgrass control. Although alachlor + dinoseb, 1 + 1.5 lb/A, preemergence resulted in good control (80% crabgrass), the same combination at 0.5 lb/A more of alachlor provided 95% crabgrass control. Alachlor + dinoseb, applied to the cotyledonary to first true leaf of soybeans, was extremely phytotoxic to soybeans causing over 85% defoliation; beans recovered, however, and alachlor + dinoseb, 1 + 1.5 lb/A, did result in a significant reduction in yields. Dinoseb is responsible for the injury to soybeans in the cotyledonary to first leaf because alachlor, applied alone at

1.5 lb/A, resulted in no soybean defoliation and only slight vigor reduction manifested as crinkling of the first trifoliate leaf.

Nitrofen + dinoseb preemergence did not give satisfactory control at the low rate tested and only fair control at the higher rate. At cracking treatments of this combination gave satisfactory control only at the high rates of 2 + 1 lb/A; however, there was 25% soybean defoliation and a 40% reduction in vigor.

Alachlor + linuron, 1 + 0.5 lb/A, or 1.5 + 0.5 lb/A, preemergence resulted in good to excellent crabgrass control with very little effect on soybean vigor. In combinations of alachlor + chlorbromuron, it appeared that in most cases the higher rate of 1.5 lb/A of alachlor was necessary.

Fluorodifen, 3 lb/A postemergence (cotyledonary to first leaf), caused over 50% vigor reduction and 35% soybean defoliation. The soybeans recovered from this initial injury and yields were similar to the control.

Dinoseb, 3 lb/A at cracking, caused excessive soybean vigor reduction and defoliation; whereas, dinoseb at 1.5 lb/A at cracking, resulted in only a slight vigor reduction.

Crabgrass control was poor with preemergence applications of dinoseb and chloramiben. Nitrofen + dinoseb, 1 + 0.5 lb/A pre and at cracking, resulted in poor crabgrass control.

Summary

Dinoseb, in combination with other herbicides, when applied at the cotyledonary to first leaf stage, resulted in excessive soybean defoliation and vigor reduction. In some cases, soybeans recovered and yields were similar to the cultivated check. Only two treatments resulted in a highly significant yield reduction; they were alachlor + dinoseb, 1 + 1.5 lb/A, applied to cotyledonary to first leaf of soybeans and chloramiben, 3 lb/A preemergence. Fluorodifen caused considerable soybean vigor reduction and defoliation when applied postemergence to soybeans.

Table 1. The effect of time of application on soybeans and weed control.

	Treatment	Rate lb/A	Time Applied	%Crabgrass Control 7/1/70 [1]	%Soybean Vigor Reduction 7/1/70 [1]	%Defoliated Soybeans 7/1/70 [1]	Soybeans Bu/A
1.	Control			7.5	0	0	27.7
2.	Control Cultivated			0	0	0	28.5
3.	Chloramiben + Dinoseb	1.5 + 3	pre	90	0	2.5	29.1
4.	Chloramiben + Dinoseb	1.5 + 3	at cracking	95	3	22.5	24.8
5.	Chloramiben + Dinoseb	1.75 + 1.5	at cracking	95	22.5	12.5	26.0
6.	Nitrofen (TOK) + Dinoseb	1.0 + 1.5	pre	50	2.5	0	29.5
7.	Nitrofen (TOK) + Dinoseb	2.0 + 1.0	pre	72.5	0	0	30.0
8.	Nitrofen (TOK) + Dinoseb	1.0 + 0.5	at cracking	62.5	2.5	0	28.5
9.	Nitrofen (TOK) + Dinoseb	2.0 + 1.0	at cracking	95	42.5	25	25.0
10.	Alachlor + Dinoseb	1.0 + 1.5	pre	80	0	0	28.3
11.	Alachlor + Dinoseb	1.5 + 1.5	pre	95	2.5	0	27.4
12.	Alachlor + Dinoseb	1.0 + 1.5	at cracking	100	27.5	12.5	25.5
13.	Alachlor + Dinoseb	1.5 + 1.5	at cracking	100	25	7.5	26.5
14.	Alachlor + Dinoseb	1.0 + 1.5	Cotyledonary to 1st leaf	97.5	50	90	19.4
15.	Alachlor + Dinoseb	1.5 + 1.5	Cotyledonary to 1st leaf	100	47.5	85	27.3
16.	Alachlor + Linuron	1.0 + 0.5	pre	87.5	5.0	0	28.6
17.	Alachlor + Linuron	1.5 + 0.5	pre	97.5	7.5	0	27.7
18.	Alachlor + Chlorbromuron (Maloran 50W)	1.0 + 0.5	pre	87.5	2.5	0	29.4
19.	Alachlor + Chlorbromuron (Maloran 50W)	1.5 + 0.75	pre	95	5	0	26.6
20.	Chloramiben	3	pre	32.5	0	0	22.6
21.	Chloramiben	1.5	pre	67.5	0	0	27.5
22.	Chloramiben	1.5	at cracking	90	0	0	27.8
23.	Dinoseb	3	pre	32.5	2.5	0	29.3
24.	Dinoseb	3	at cracking	85	40	32.5	24.3
25.	Dinoseb	1.5	pre	45	0	0	28.2
26.	Dinoseb	1.5	at cracking	55	2.5	0	28.4
27.	Nitrofen (TOK 50WP)	1.0	pre	60	2.5	0	29.0
28.	Nitrofen	2.0	pre	80	2.5	0	27.8
29.	Nitrofen	1.0	at cracking	87.5	5	0	29.4
30.	Nitrofen	2.0	at cracking	87.5	5	0	29.1

Table 1. (contd.)

	Treatment	Rate lb/A	Time Applied	%Crabgrass Control 7/1/70 [1/]	%Soybean Vigor Reduction 7/1/70 [1/]	%Defoliated Soybeans 7/1/70 [1/]	Soybeans Bu/A
31.	Alachlor	2.0	pre	92.5	2.5	0	27.1
32.	Alachlor	1.0	pre	100	5	0	28.0
33.	Alachlor	1.5	pre	90	0	0	28.4
34.	Alachlor	1.0	at cracking	100	5	0	28.1
35.	Alachlor	1.5	at cracking	100	10	0	29.6
36.	Alachlor	1.0	Cotyledonary to 1st leaf	62.5	5	0	27.9
37.	Alachlor	1.5	Cotyledonary to 1st leaf	85	7.5	0	26.5
38.	Linuron	0.5	pre	77.5	2.5	0	27.1
39.	Chlorbromuron 50W	0.5	pre	70	0	0	27.6
40.	Chlorbromuron 50W	0.75	pre	70	0	0	26.7
41.	Fluorodifen (C-6989)	3.0	pre	9	5	2.5	26.7
42.	Fluorodifen	3.0	at cracking	100	20	0	26.7
43.	Fluorodifen	3.0	Cotyledonary to 1st leaf	100	50	35	28.3
44.	Dinoseb	0.5	pre	52.5	0	0	29.7
45.	Dinoseb	0.5	at cracking	20	2.5	0	26.9
46.	DCPA (Dacthal)	4.0	pre	72.5	7.5	0	26.7
47.	DCPA + Linuron (Shamrox)	4.0 + 0.5	pre	90	0	0	28.0

[1/] Percentage based on visual ratings from 0 to 100.

LSD 0.05 = 3.5
LSD 0.01 = 4.6

Breeding and Evaluation of Kentucky Bluegrass for Turf

A. J. Powell
Department of Agronomy

Purpose and Objectives

Many new and improved Kentucky bluegrass varieties appear at the consumer market each year. Likewise, many of the older, unadapted varities appear and the consumer, whether a golf course superintendent, sod producer or homeowner, must select one or more of these varieties with little background knowledge of their performance. It is the purpose of this test to evaluate the present varieties along with new and experimental varieties to determine which of these are best adapted to our Maryland transitional climatic zone.

Procedure

The basic experiment in this regional project was designed and has been maintained similarly in all cooperating states in the Northeast. Forty-two Kentucky bluegrass clones (see Table I) were seeded in the fall of 1968. Two vegetative clones were added as sod during the fall of 1969. Located at the Plant Research Farm, the basic experiment includes all 44 varieties and was fertilized with 3 lbs. N/1000 $ft.^2$/yr. and mowed at $1\frac{1}{2}$". To supplement this test, two additional experiments were located at the Plant Research Farm and at Centerville to give information on these varieties grown at a $2\frac{1}{2}$" mowing height at differing climatic regions of Maryland. Due to a shortage of seed, seven of the original 44 varities were excluded from the latter two experiments.

All experiments included 3 replications and were rated monthly for color, density and overall quality. Also, when diseases were present, the varieties were rated according to their resistance.

Results

It is difficult to evaluate 44 varieties at three locations and determine

which is best. The individual evaluations are discussed below and examples of superior or inferior varieties in the Plant Research Farm tests are given. The performance of the Kentucky bluegrass varieties are given in Table 1.

Density. The density of all plots improved to an acceptable level. However, with the early spring Helminthosporium leaf spot and summer dollar spot infestations, the density of many plots that were severely infected decreased. Even in very healthy plots, some varieties had a much greater density of leaves per unit area than others. At the 1½" cut, Warren's A-20 and A-34, Newport, Belturf, Windsor, Fylking and Merion were superior varieties and at the 2½" cut, Cougar Merion, Park,Primo, Warren's A-34, Newport and Jacklin's S-21 were superior. Inferior varieties at the 1½" cut included Warren's A-10, Delta, Cougar, NJE-P5 and Nuggett, and at the 2½" cut, NJE-P-56, Sodco, NJE-P-114, NJE-P-5 and Prato were inferior. It is obvious that some varieties such as Cougar perform quite well at a 2½" cut and very poorly at 1½".

Color. To put much weight upon color ratings is misleading. It is only an aesthetic evaluation and is not a serious problem since color changes with season and fertilization practices. Generally, however, a dark green color is desired. Best color was exhibited by NJE-P-5, Warren's A-20 and A-10 and Sodco at the 1½" height and by NJE-P-56, Sodco, NJE-P-5 and WK-411 and 412 at the 2½" height. Inferior color was exhibited by K8-145, Kenblue, Cougar, and Geary cut at 1½", and by Geary, Southport, Cougar and Delta cut at 2½"

Quality. The overall appearance or desirability of the turf is the basis of the quality ratings. Some emphasis is placed upon color, density and disease damage, but coarseness, erectness and plant variability are also included within this rating. Those giving best quality ratings at the 1½" height were Warren's A-20 and A-34, Belturf, Ba6124, WK-411 and Fylking and at the 2½" height superior varieties were Merion, K8-146, WK-412, Primo, PP-1, WK-411, and Fylking. At the 1½"

height of cut, Warren's A-10, Delta, Nuggett, NJE-P-5, and Cougar were inferior. At $2\frac{1}{2}$ inches, NJE-P-5, P-114 and P-56, Sodco, Delta and Prato were inferior.

Disease. Dollar spot ratings were taken in July and twice during August. Varieties were differentially affected. Minn-6, Fylking, Warren's A-10, Park, Ba6124, and WK-412 were most resistant at the $1\frac{1}{2}$" height and Kenblue, Jacklin's S-21, Palouse, Minn-6 and Geary were most resistant at $2\frac{1}{2}$ inches. Most susceptible were Palouse, K8-145, Nuggett, Warren's A-34 and P-69 cut at $1\frac{1}{2}$" and P-56, Ba6124, Belturf, Warren's A-34 and K8-144 cut at $2\frac{1}{2}$".

Summary

Due to difficulties in evaluating the numerous varieties, an attempt has been made to summarize results. A plus (+) was assigned to those varieties which performed in the top 1/3 and a minus (-) to those which were in the bottom 1/3. Intermediates were left blank. These were taken from averages of the three replications at three locations. Using this method, the same weight was given to density, color, quality and disease. A total of $\pm$ points was possible.

Overall performance rankings of all varieties for 1969 and 1970 are listed in Table 2. Although only two years' data are available, certainly those varieties with high negative values should be excluded as unadapted. In contrast, those varieties with high positive values may be considered well adapted varieties. This ranking also gives some basis of comparison for experimental varieties (listed by number).

It is likely that some varieties that look good now will degenerate in performance after 3 or 4 years. This is known to happen with Newport. With this in mind, one can compare 1969 and 1970 results realizing that the rankings listed in Table 2 will change in subsequent years.

Table 1. Performance of 44 Kentucky bluegrass varieties according to evaluation method and location. Pluses and minuses indicate superior or inferior performance.

Variety	Density Location* 1	2	3	Quality Location 1	2	3	Color Location 1	2	3	Disease Location 1	2	Total Points
Newport	+	+	+	+		+	-	-				+3
Ba 6124 (Scott)	-			+			+		+	+	-	+2
Windsor	+	-	+	-	-	-			+		+	+3
S. Dakota Cert.			-	-			+			+	+	+1
Arista				+		-	+	+		+		+1
Southport	-		-	-	+			-	-	-	-	-6
Nuggett	-	-	-	-	-	-	-	+	-	-	-	-9
Palouse			-		-	-	-	-	-	-	+	-6
A-34 (Warren)	+	+		+	+			-	-	-	-	0
Pennstar	+	-	-						+	+		+1
Cougar	-	+	+	-		+	-	-	+	-		-1
Park		+	-		+	-		-	-	+	+	0
Geary				-	-	-	-	-	-	+	+	-4
S-21 (Jacklin)		+	+			+			+	+	+	+6
Fylking (0217)	+			+	+		+	+		+	+	+7
Merion	+	+	+	+	+	+			+	-		+6
Delta		-	+	-	-	+		-		-		-4
Prato		-	+	-	-	+	-	-	+	-		-3
WK-408 (Weibulls)	+	+		+		-						+2
WK-411 (Weibulls)	+	+	-	+	+		+	+			+	+6
WK-412 (Weibulls)	+		+	+	+	+	+	+		+	+	+9
Minn-6				-	-	+	-	-	-	+	+	-2
Sodco		-	+	-			+	+	+		-	+1
Primo		+		+	+		-		-			+1
Kenblue		-		-	-		-	-	-		+	-5
Belturf	+			+		+		+	+		-	+4
NJE P-56	-	-	-	-	-	-	+	+	+	-	-	-5
NJE P-114	-	-	-	-	-	-	+	+		+	-	-4
NJE P-5	-	-	+	-	-	-	+	+		+	-	-2
NJE P-35**	-						+					0
NJE P-69**							+			-		0
NJE P-115**	+			+						-		+1
R. I. PP-1	+	+			+	+					+	+5
PSU K-107	+		-	+	+	-		+	-			+1
Zwartberg**							-					-1
Campus**												0
PSU K-162**							-					-1
PSU K-128**							-			-		-2
K8-146		+			+		-			+	-	+1
K8-145		-	-	-			-	+		-	-	-5
K8-144			+			+			+	-	-	+1
A-10**	-			-			+			+		0
A-20**	+			+			+					+3

* Location: 1. $1\frac{1}{2}$" cut, Plant Research Farm, 2. $2\frac{1}{2}$" cut, Plant Research Farm, 3. $2\frac{1}{2}$" cut, Princeton Turf Farms.

** These varieties were only included at Location 1 and total points may not be indicative of their performance.

Table 2. Overall ranking of the Kentucky bluegrass clones for 1969 and 1970.

1969 (± 10 points possible)	1970 (± 11 points possible)	1969 and 1970 Combined (± 21 points possible)
+9 Fylking	+9 WK-412	+16 Fylking
+7 K8-146	+7 Fylking	+14 WK-412
+6 PSU K-107	+6 Merion	+11 Merion
+5 Merion	+6 S-21	+10 WK-411
+5 WK-412	+6 WK-411	+ 9 Belturf
+5 Belturf	+5 PP-1	+ 8 PP-1
+5 K8-145	+4 Belturf	+ 8 K8-146
+4 Newport	**+3 Warrens A-20	+ 7 K-107
+4 South Dakota Cert.	+3 Newport	+ 7 Newport
+4 WK-411	+3 Windsor	+ 5 South Dakota Cert.
+3 Arista	+2 Ba 6124	+ 4 S-21
+3 R. I. PP-1	+2 WK-408	+ 4 K8-144
+3 K8-144	+1 South Dakota Cert.	+ 4 Arista
+2 Prato	+1 Arista	**+ 3 Warrens A-20
*+2 NJE P-115	+1 Pennstar	*+ 3 P-115
*+2 Campus	+1 Sodco	+ 3 Windsor
+1 Sodco	+1 Primo	+ 2 Ba 6124
*+1 Zwartberg	*+1 P-115	+ 2 Sodco
*+1 PSU K-162	+1 K-107	*+ 2 Campus
0 Ba 6124	+1 K8-146	+ 1 WK-408
0 Windsor	+1 K8-144	+ 1 Pennstar
0 A-34	** 0 Warrens A-10	0 Warrens A-34
0 Pennstar	* 0 Campus	** 0 Warrens A-10
0 Kenblue	* 0 P-69	0 Primo
0 NJE P-114	* 0 P-35	* 0 P-35
* 0 NJE P-35	0 Park	* 0 P-69
* 0 NJE P-69	0 Warrens A-34	* 0 Zwartberg
* 0 PSU K-128	-1 Cougar	* 0 K-162
-1 WK-408	*-1 K-162	0 K8-145
-1 Primo	*-1 Zwartberg	- 1 Prato
-1 NJE P-56	-2 P-5	- 2 Park
-2 Nuggett	*-2 K-128	*- 2 K-128
-2 Park	-2 Minn-6	- 4 P-114
-2 S-21	-3 Prato	- 5 P-5
-3 Palouse	-4 P-144	- 5 Minn-6
-3 Delta	-4 Geary	- 5 Cougar
-3 Minn-6	-4 Delta	- 5 Kenblue
-3 NJE P-5	-5 Kenblue	- 6 P-56
-4 Cougar	-5 P-56	- 7 Delta
-6 Geary	-5 K8-145	- 9 Palouse
-6 Southport	-6 Palouse	-10 Geary
	-6 Southport	-11 Nuggett
	-9 Nuggett	-12 Southport

* These varieties were only included at one location and total points may not be indicative of their performance (possible ± 8 points only).

** These varieties were only included in the 1970 tests at one location and total points may not be indicative of their performance (possible ± 4 points only).

Tufcote Bermudagrass - Adaptations and Requirements for Turf Uses

A. J. Powell
Department of Agronomy

Purpose and Objectives

Since its release as a bermudagrass variety in 1962, Tufcote plantings throughout central and southern Maryland have multiplied yearly. Since Kentucky bluegrasses are poorly adapted to both sandy or heavy clay soils and require special summer management for survival, the popularity of Tufcote is natural. It is well adapted to many of the unusual soil types being used for home lawns and its maintenance requirements are not so critical. However, to maintain high quality Tufcote that will survive cold winters, much information is needed on proper fertilization and mowing procedures. As its homeowner popularity increases, additional information is needed concerning keeping aesethic qualities throughout the year, even when the bermuda is dormant. These experiments were designed to: establish optimum fertilization techniques and mowing procedures; investigate which cool-season grasses blend best with Tufcote and offer best winter color and least competiveness; and to determine what influences these management regimes might have upon its winter survival and subsequent spring green-up.

Procedures

Experiment A. Fertilization. As in previous years, nitrogen was applied at rates varying from 3 to 9 lbs. of nitrogen per 1000 ft.^{2}. Dates and rates varied according to the nitrogen source and fertilization regime desired. The three forms of nitrogen used included a quickly available source (urea), a slowly available synthetic organic source (ureaformaldehyde) and a slowly available natural organic source (processed organic wastes, Agrinite).

Experiment B. Overseeding. The annual and perennial cool-season turf species overseeded into the bermuda turf included annual ryegrass, Penncross bentgrass, Pennlawn red fescue, Kentucky-31 tall fescue, Merion Kentucky bluegrass and redtop. One check plot was verticut but not seeded and another was neither verticut or seeded. Two or three seeding rates were used and mowing heights were set at either one or two inches.

Experiment C. Mowing. Mowing heights of 1/2, 1, and 1-1/2 inches were maintained and each mowing height was cut every 2, 3, 7 or 14 days throughout the growing season. Visual ratings were taken on color, quality and winter survival.

Results

Experiment A. Fertilization. Although approximately 10% of the Tufcote winter killed, the damage could not be correlated with the high or low fertilizer rates. Monthly urea applications or bimonthly applications of urea or urea-formaldehyde gave best color and quality (Table 1). With the early season application, at least three times as much actual nitrogen from UF or the organic source was required to give an equal turf response as compared with the NH_4NO_3. The organic nitrogen was generally inferior to both UF and NH_4NO_3 for the entire growing season. Although the monthly applications of soluble nitrogen gave very good color throughout the year, one application of UF at 9# N/1000 ft.^{2} applied in April gave near equal season long color.

Dollar spot was quite severe throughout July and August. Disease severity was greatest on plots receiving low nitrogen rates. Generally, all of the NH_4NO_3 plots and most of the UF plots were only slightly damaged but plots fertilized with the organic nitrogen were consistantly more severely infested with dollar spot (Table 1).

Experiment B. Overseeding. All overseeded species germinated; however, only the annual ryegrass had sufficient seedling vigor to mask the dormant bermuda during the winter months. All plots overseeded with Kentucky bluegrass were very dense and green but this was a result of bluegrass survival throughout the preceding years. As can be noted from Table 2 Kentucky bluegrass completely dominated all plots in which it was seeded and certainly survived the summer heat to dominate the existing Tufcote.

During spring (Table 2 all species could be detected but only annual ryegrass, tall fescue, and Kentucky bluegrass existed in sufficient quantities to mask the dormant bermuda. Bentgrass, red fescue and redtop were complete failures. With all species, however, the higher mowing height and seeding rate resulted in best cover. Kentucky bluegrass and the tall fescue at the 2-inch height of cut were the only species to survive the summer.

Table 2. The effect of mowing heights and species on percent cover of overseeded grasses in Tufcote bermuda.

Treatment	Lbs. Seeded Per 1000 Ft.^{2}	Percent Cover of Overseeded Specie			
		April 21		August 24	
		1" Cut	2" Cut	1" Cut	2" Cut
Annual Ryegrass	7#	26	26	0	0
Annual Ryegrass	14#	43	56	0	0
Bentgrass	½#	6	6	0	0
Bentgrass	1#	10	16	0	0
Red Fescue	1#	10	13	0	0
Red Fescue	2#	16	23	0	0
Tall Fescue	3#	0	10	0	27
Tall Fescue	5#	3	23	3	33
Tall Fescue	7#	0	33	0	50
Kentucky Bluegrass	½#	73	90	70	90
Kentucky Bluegrass	1#	80	90	90	90
Redtop	½#	3	3	0	0
Redtop	1#	3	6	0	0

Experiment C. Mowing. Frequent and close mowing produced best quality Tufcote. Generally, plots mowed every two or three days at the one inch height of cut produced high quality Tufcote that did not suffer from scalping injury. Especially for the less frequently mowed plots, scalping injury occurred several times during the summer months.

Summary

High quality Tufcote bermudagrass can be maintained throughout its growing season but overall success with overseeding for winter quality is still minimal. Since bermudagrasses have high requirement for nitrogen, they must be fertilized at least monthly during the summer if using a soluble source of nitrogen or fertilized at very high rates (6 to 9 lbs. of N) when using slow release forms of nitrogen applied only during late spring. With this fertilization program, dollar spot injury should be minimal; however, the Tufcote should be mowed at least twice per week to maintain high quality turf. If overseeding is attempted, only the high seeding rates of annual ryegrass have provided enough fall and winter cover to warrant its use. Kentucky bluegrass will give good cover, but when used annually, it will dominate the Tufcote. No correlations have existed between mowing height or fertilization and winter survival.

Table 1. Selected color and disease ratings of Tufcote bermudagrass after several nitrogen fertilization regimes.

Rate and Time of Nitrogen Application	COLOR[1]									DISEASE[2]		
	May 25			Aug. 24			Oct. 6			Aug. 24		
	NH_4NO_3	UF	Org	NH_4NO_3	UF	Org	NH_4NO_3	UF	Org	NH_4NO_3	UF	Org
3 lb. N April	8.00	6.66	6.33	2.66	4.33	3.00	1.00	3.00	1.66	2.33	3.66	4.33
6 lb. N April	8.00	7.33	7.33	6.33	6.33	3.33	3.00	3.66	2.00	1.33	1.66	3.66
9 lb. N April		8.00	7.66		7.66	4.66		5.00	3.00		1.00	2.33
1 lb. N in April, June, August	6.00		4.66	7.66		1.66	3.33		2.33	3.33		8.00
2 lb. N in April, June, August	7.66	6.66	5.66	9.00	8.33	5.00	4.33	4.33	3.00	1.0	1.66	5.33
1 lb. N Monthly April thru Sept.	7.00		5.66	8.33		7.66	5.66		3.33	1.0		1.66
3 lb. N in April, July	7.66	8.00	6.66	6.66	7.66	6.66	3.00	4.00	2.33	1.33	1.33	2.66

[1] Color Rating - 1-poor color, 9-best color

[2] Disease Rating - 1-very little disease, 9-severe disease

Effectiveness and Residual Properties of Several Herbicides Used in Turfgrass Areas

A. J. Powell
Department of Agronomy

Purpose and Objectives

With the increased demand for aesthetic turf, whether on home lawns, golf courses, sod farms or other recreational areas, the need for effective and yet environmentally safe herbicides becomes obvious. Crabgrass has long been considered a serious turf contaminant and many new herbicides have been tested and marketed to control crabgrass before it emerges as a pollutant. The objectives of this study were to determine the herbicide effectiveness of the pre-emergence crabgrass herbicides and to study the long term effects these herbicides may have on desirable turfgrasses if repeated or yearly applications are made.

Procedures

A turfgrass area heavily infested with crabgrass was selected at the University of Maryland Plant Research Farm. In 1965, this area was seeded with a Kentucky bluegrass-red fescue mixture. Since the spring of 1966, this turf area has been treated yearly with a spring application of the selected pre-emergence herbicide. These herbicides have been applied to the same plots for five consecutive years. Also, to insure the presence of crabgrass, the turf area has been maintained at a 1" height of cut and has been overseeded with crabgrass annually.

The commercially available pre-emergence herbicides used throughout this experiment are listed in Table 1. The rates of application are those suggested by the manufacturer at the time the experiment was initiated. Many ineffective experimental herbicides were only applied one or two years and are not included in Table 1. Visual estimates were made for percent control, percent grass cover, broadleaf weeds and overall turf quality.

Results

All presently marketed pre-emergence herbicides used in this test gave better than 90% crabgrass control; however, bandane gave less (92%) control than bensulide, benefin, terbutrol, siduron, DCPA and tricalcium arsenate (Table 1). Crabgrass control was extremely good with DCPA wp (98%) tricalcium arsenate (98%) and siduron g (98%). Due to the excellent early season weather conditions, the bluegrass turf was exceptionally dense, even under the close mowing, and crabgrass encroachment was minimal.

Although noticeable turf injury does not seem to increase to any great extent with each subsequent pre-emergence application, the overall turf cover has definitely decreased on some plots. Bandane and tricalcium arsenate have reduced turf cover to 30 and 49 percent, respectively. On the other hand, bensulide plots maintained 95% turf cover (compare with 89% cover on check plots). Since bandane and tricalcium arsenate are quite residual chemicals, it is very possible that their residue levels within the soil are high. If this is true, certainly they should not be applied at such high concentration or as often as they have been applied in this test.

Compared to previous years, fewer broadleaf weeds existed, but tricalcium arsenate continued to give best broadleaf weed control. Bandane, benefin, bensulide ec, DPCA g and terbutrol wp gave poorest broadleaf weed control.

Overall turf quality was best with bensulide g, siduron g and benefin and poorest with bandane and tricalcium arsenate.

Summary

Pre-emergence herbicides currently recommended by the University for crabgrass control continue to be the most effective herbicides and these also present fewer problems with residual carryover and subsequent turf injury. Bensulide, DCPA, siduron, and benefin were superior in these tests. Very small differences were noticed between formulations tested. Since bandane and tricalcium arsenate are environmentally stable chemicals and resulted in serious turf injury and a lack of turf quality, they should not be used for crabgrass control in bluegrass turf.

Table 1. Crabgrass control and turf response after five annual applications of pre-emergence herbicides. Data was recorded in December, 1970 and presented as a mean of 4 replications.

Herbicide Formulation[1]	A.I. Per Acre	% Crabgrass Control	% Turf Cover	Turf Quality[2]	Broadleaf Weeds[3]
Bandane g	35	92	30	1.75	5.25
Benefin g	1.5	95	94	7.50	4.25
Bensulide g	10	95	95	8.25	3.00
Bensulide ec	10	97	92	7.25	4.25
DCPA g	11	97	89	6.50	4.50
DCPA wp	11	98	90	7.00	3.25
Terbutrol g	10	94	89	7.25	4.00
Terbutrol wp	10	95	89	6.75	5.50
Tricalcium arsenate	375	98	49	4.25	1.00
Siduron g	10	98	91	8.00	2.25
Siduron wp	10	95	93	7.25	3.25
Check	- -	81	89	7.75	2.75

[1] Formulation : g = granular, ec = emulsifiable concentrate, wp = wettable powder.

[2] Rating Scale: 10 = normal or best, 1 = poor quality.

[3] Rating Scale: 1 = no weeds, best control, 10 = highest weed content.

Effects of Air Pollution on Turfgrass Species Grown in Maryland

G. Richards, A. J. Powell, and C. L. Mulchi
Department of Agronomy

Purpose and Objectives

Damage to turfgrass from smog or air pollution began to appear in California in the early 1950's but has since been observed in other areas throughout the United States. The damage generally appears as chlorotic spotting along the leaf blades and leaf tip burn. Due to the increased levels of air pollutants in the atmosphere (0 to 0.2 ppm ozone) in the Washington D. C. area, a study was initiated to determine the effects of ozone on the turfgrass species grown in this area.

The general objectives of the program, which was initiated in the fall of 1970, are as follows: (1) To determine the general susceptibility of many of the common turfgrass species and varieties to damage by ozone at various concentrations in air; (2) To determine the effects of such factors as plant age, moisture status, and fertility status on the susceptibility of the various turfgrass species and varieties to ozone damage; (3) To examine the variability among established bluegrass varieties to ozone damage, and; (4) To examine the relationships between such chemical factors as carbohydrates, total nitrogen levels and levels of phenolic compounds in established bluegrass varieties with the varying degrees of damage from ozone.

Procedures

Several experiments have been carried out thus far to obtain information pertaining to the first two objectives. The analysis of the data for each study is incomplete at this time. Included in this report is a brief

description of five experiments and some of the data obtained from each study.

Experiment I -- Plugs of 4.5 inches in diameter were cut from eight types of established turfgrasses which were located on the Hopkins farm. The selections were Tufcote bermuda, Meyer zoysia, Merion bluegrass, Kenblue bluegrass, Kentucky 31 tall fescue, NK-100 ryegrass, Penncross bentgrass, Pennlawn red fescue and Poa annua. Nine cans of each selection were divided into groups of threes and exposed for two hours to ozone concentrations in air of 0.2, 0.3, and 0.4 ppm, respectively, in Dr. Harry Mencer's fumigation chamber located in the Plant Industry Station at Beltsville, Maryland. The temperature in the chamber was 81± 4°F, the relative humidity was 73± 7% and the light intensity was 1200 ft-c. A randomized complete block design was used for the study. The plants were returned to the greenhouse and scored one week later for damage. The rating system was a visual method in which each plug was rated from 0 to 10 with 0 being no visual damage and 10 with 50% of the blade surfaces being killed. No controls were included.

Experiment II -- Sixteen turfgrasses including six bluegrasses, five perennial ryegrasses, two tall fescues, and one each of red fescue, redtop and bentgrass were seeded in 4-inch plots in the greenhouse. Two weeks after germination, the grasses were clipped to 2 inches and exposed to 0.3, 0.4, and 0.5 ppm ozone concentrations in air, respectively, for periods of three hours. Each type was replicated three times in a randomized complete block design for the exposures and compared with controls. The temperature in the chamber was 81± 2°F, the relative humidity was 61± 3%, and the light intensity equaled 1400 ft-c. In addition to visual estimates of damage, the length and dry weights of regrowth vegetation were measured one week following exposure.

Experiment III -- Seedlings which were not used in II were allowed to grow in the greenhouse for 10 weeks, then exposed to ozone. The same experimental design, treatments, number of replications and observations

were employed for Experiment III as noted in Experiment II.

Experiment IV -- The influence of moisture on the susceptibility of the sixteen turfgrass selections noted in Experiments II and III was investigated in a split-plot experiment where half the plants were misted and the other half remained dry. Four replications of 15-week old plants were employed and the ozone treatment was 0.60± 0.04 ppm ozone concentration in air for a duration of 6 hours. The plants were misted for one minute at 20-minute intervals. The temperature was 75± 3°F and the relative humidity 85± 15% -- i.e. when the mist was turned on the humidity increased to 100% then returned to about 70%. The plants were scored and leaf growth and dry weights were obtained one week after exposure as discussed in Experiment II.

Experiment V -- The influence of nitrogen fertilization on the susceptibility of the sixteen turfgrass selections noted in Experiment II, except Merion bluegrass and Norlea ryegrass, was investigated. Six uniform cups of each turfgrass type were selected from a group of 8-week old plants and three of the cups of each type were fertilized with urea formaldehyde (38%) in liquid form at a rate of 10 lbs. per 1000 sq. ft. After allowing the plants to grow two weeks in the greenhouse, they were exposed to ozone in air at a concentration of 0.50± 0.03 ppm. The temperature was 87± 3°F and relative humidity was 70± 15%. One week after exposure, the plants were scored as described in Experiment I.

Results

Increasing the ozone concentration levels from 0.2 to 0.4 ppm progressively increased the degree of damage to the turfgrass species; however, the Tufcote bermuda, Meyer zoysia and Merion bluegrass appeared to be resistant to ozone in air at the 0.2 and 0.3 ppm concentrations, Table 1. Kenblue bluegrass and K-31 tall fescue showed moderate resistance to ozone and NK-100 ryegrass, Penncross bentgrass, Pennlawn red fescue and Poa annua

appeared to have much higher susceptibility to damage than the others in the experiment.

The two-week old seedlings were damaged to a larger extent than were the ten-week old seedlings, Table 2. The general effect of younger plants being more susceptible is exhibited throughout nearly all of the sixteen selections except S. Dakota bluegrass, redtop, and Pennlawn red fescue. However, the bluegrass in general appeared to have over 50% less damage at the ten-week old stage compared to the two-week old seedlings. The ryegrasses also showed much lower susceptibility to damage in the ten-week old seedlings.

The seedlings which received additional water during their exposure show slightly greater susceptibility to damage from ozone, Table 2. However, the plants which were not misted were exposed to the higher humidity caused by the misting which possibly could have caused their rating to be higher than if they had been in a dryer atmosphere. The trend for greater susceptibility to ozone damage when misted was consistent throughout the sixteen selections except for S. Dakota bluegrass and Penncross bentgrass and Fylking bluegrass.

The addition of nitrogen tended to reduce the susceptibility of the turfgrass selections to ozone damage (Table 3) except K-31 tall fescue. Fylking bluegrass and Norlea ryegrass were the only species which showed increased damage when fertilized with nitrogen at the rate of 10 lbs. per 1,000 sq. ft. However, the control plants tended to show less damage for the concentration of ozone employed, 0.5 ppm than in previous studies.

Summary

A study of the effect of ozone on turfgrass species commonly grown in Maryland was initiated in 1970. Results from several experiments suggest that a wide range of species susceptibility exists and interactions with environmental factors such as moisture and fertility are important. Plant

age appears to be important because younger plants tend to have greater susceptibility to damage than older plants at ozone concentrations equal to or greater than 0.3 ppm.

Table 1. Effects of Ozone on Several Trufgrass Species Common To Maryland, Experiment I. Visual Ratings.

Name	Rating Average Per Pot			General Mean
	Ozone Level			
	0.2 ppm	0.3 ppm	0.4 ppm	$\bar{x}$
Tufcote Bermuda	0	0	0.33	0.11
Meyer zoysia	0	0	0.33	0.11
Merion bluegrass	0	0	0.67	0.22
Kenblue bluegrass	0.33	0.67	2.67	1.22
K-31 tall fescue	1.33	2.00	2.33	1.88
NK-100 ryegrass	1.67	2.33	5.33	3.11
Penncross bentgrass	2.67	3.33	5.33	3.77
Pennlawn red fescue	3.33	5.33	6.00	4.88
Poa annua	4.00	6.00	7.67	5.89
Mean	1.48	2.18	3.41	

Table 3. The effect of Nitrogen Fertilization on Susceptibility of Turfgrass Selections to Ozone (0.5 ppm) Damage

Turfgrass Selection	Visual Ratings a/	
	Nitrogen 10 lbs/1000 sq. ft.	No Nitrogen
Kenblue bluegrass	0.66	1.33
S. Dakota bluegrass	0.33	1.00
Fylking bluegrass	1.66	0.33
Canada bluegrass	2.33	3.33
Pennlawn red fescue	0.33	1.66
K-31 tall fescue	0.33	0.33
Fawn tall fescue	0.00	1.00
Redtop	0.00	1.00
Penncross bentgrass	0.00	1.33
Norlea ryegrass	1.00	0.33
Pennfine ryegrass	0.00	0.33
Pelo ryegrass	2.00	3.00
Linn ryegrass	1.00	2.33
Manhattan ryegrass	1.00	3.33
Mean	0.76	1.47

a/ The rating system was visual from 0 to 10 with zero representing no visual damage and 10 representing plants having about 50% of their blades killed.

Table 2. Effects of Age of Turfgrass Selections and Water on Their Susceptibility to Ozone Damage Experiments II, III, & IV. Visual Ratings

Turfgrass Selection	Two Weeks II				Ten Weeks III				Misted IV	Non-Misted IV
	ppm Ozone			Mean	ppm Ozone			Mean	ppm Ozone	ppm Ozone
	0.3	0.4	0.5	$\bar{x}$	0.3	0.4	0.5	$\bar{x}$	0.6	0.6
Merion bluegrass	2.00	5.67	7.67	5.10	1.33	2.67	3.00	2.33	4.50	3.00
Windsor bluegrass	0.67	4.67	6.33	3.87	1.00	1.67	2.00	1.56	2.75	1.50
Kenblue bluegrass	1.00	2.33	2.33	1.53	0.33	1.00	1.33	0.89	3.00	2.25
S. Dakota bluegrass	0.00	1.00	1.67	0.87	1.00	2.67	2.67	2.22	2.00	2.75
Fylking bluegrass	0.00	3.67	6.00	2.87	1.00	0.67	1.00	0.89	2.50	2.50
Canada bluegrass	2.67	4.67	7.67	5.00	1.00	1.67	3.67	2.11	5.00	3.75
Pennlawn red fescue	0.67	5.33	6.33	4.10	3.00	5.67	4.00	4.22	5.00	4.75
K-31 tall fescue	2.00	4.67	6.00	4.20	1.67	3.00	4.00	2.89	3.25	3.00
Fawn tall fescue	2.00	4.33	5.33	3.87	1.67	2.00	3.00	3.33	5.00	4.25
Redtop	2.00	4.67	8.67	5.00	5.00	6.00	5.67	5.55	7.75	6.25
Penncross bentgrass	0.67	1.33	8.00	3.33	1.00	2.33	3.33	2.22	3.25	3.25
Norlea ryegrass	3.33	4.67	5.00	4.33	1.00	2.67	3.00	2.22	2.25	1.75
Pennfine reygrass	2.33	4.33	4.67	3.77	0.33	2.33	3.33	2.00	2.50	2.00
Pelo ryegrass	2.33	4.67	4.00	3.67	1.00	2.00	2.67	1.89	2.25	1.25
Linn reygrass	1.67	4.67	4.33	3.53	2.00	2.67	3.00	2.56	3.50	2.25
Manhattan ryegrass	1.33	3.33	3.33	2.67	0.67	2.33	2.33	1.78	2.00	1.00
Mean	1.54	4.00	5.46		1.44	2.58	3.00		3.56	2.84

High-Lysine (Opaque-2) Corn Field Tests - 1970

R. G. Rothgeb

Department of Agronomy

Purpose and Objectives

Second-year field tests were conducted to compare the performance of corn hybrids producing the opaque-2 type of kernel, one with another and with hybrids producing normal starchy kernels. (1969 test results were reported in Crop and Soils Research Progress Report, Vol. 3, Dec. 1970. U. of Md. Agronomy Dept.).

Procedure

As in 1969 two field tests were conducted - one on the U. of Md. Plant Research Farm and the other on the Wye Institute Farm. Each test was located on uniform silt loam soil sufficiently isolated from other corn to minimize pollen contamination. In both tests each of 16 hybrids was hand-planted on 4 replicate randomized plots - each plot 2 (30" rows) x 15 ft. Planting dates - Wye farm, May 20, and Research farm, May 28. Seeding rate was approximately 23,000 seeds per acre. Fertilizer applications were 700/lbs. 16-8-8 plow-down and 300 lbs. 5-10-10 side-row. Sources of seed for the 16 hybrids compared were as follows:

Entry no.:	1, 2, and 3 Ill. Foundation Seeds, Inc.
" "	4 through 15 Pioneer Hi-Bred Corn Company
" "	16 Carl Ross

Each O_2 hybrid from Pioneer was matched by seed of its isogenic normal - different in seed appearance but similar in progeny plant appearance. All the plants growing from normal seed were detasseled to prevent the appearance of starchy kernels on O_2 parents as a result of normal dominance.

The accompanying table gives comparative data for the 16 test entries at both test locations.

Summary

1. Results at the two test locations checked rather well.
2. Normal hybrids consistently out-yielded their O_2 counterparts - by an average difference of 12 bu. (Wye) and 14 bu. (Res. Farm)
3. Grain test wts. were similar for the two test locations, with normal hybrids averaging 6.5 to 6.9 lbs. heavier than the O_2 hybrids
4. Grain damage was higher on the Research Farm and O_2 hybrids were damaged more than normals.

Table 1. High lysine (02) hybrids in Maryland tests. 1970.

Opaque-2 vs Isogenic Normal Hybrids

HYBRIDS	Grain yields: Wye Test Bu/A*	Grain yields: C. Park Test Bu/A*	Test weight: Wye Test Lbs.	Test weight: C. Park Test Lbs.	Grain damage: Wye Test %	Grain damage: C. Park Test %
Non-paired 02 hybrids						
(1) Ill. F.S. (90x64A)43	83.1	74.8	51	52	1.1	6.7
(2) Ill. F.S. (43x37)	82.5	74.1	50	51	0.2	2.5
(3) Ill. F.S. (37x14)	66.6	87.1	48	49	1.7	5.6
(16) Ross 02	86.1	76.8	51	52	0.7	5.1
Paired 02 vs normal						
(5) P3369A N	87.6	99.5	57	58	0.7	1.7
(4) " 02	71.7	85.3	51	52	3.4	3.1
(7) P3306 N	89.2	95.3	53	55	1.0	1.6
(6) " 02	81.6	80.3	48	48	2.0	6.3
(9) P3390 N	98.2	92.9	56	57	0.5	3.1
(8) " 02	86.8	80.3	48	49	4.5	10.5
(11) P3376 N	99.8	96.6	53	55	2.6	6.4
(10) " 02	84.7	78.9	45	47	8.4	11.0
(13) P3387 N	78.8	87.7	57	57	2.1	3.4
(12) " 02	70.9	75.4	51	53	2.2	4.2
(15) P907L N	89.7	88.7	56	57	1.4	2.0
(14) " 02	75.7	76.8	50	51	1.4	4.7
Averages						
Iso N	90.55	93.45	55.33	56.90	1.38	3.03
" 02	78.57	79.50	48.83	50.00	2.98	6.63
Dif.	11.98	13.95	6.50	6.90	-1.60	-3.60

* 56 lbs/bu at 12% grain moisture

Source of seed: Ill. Foundation Seeds, Inc. Pioneer Corn Co. Carl Ross

Planting dates: Wye Inst. Farm - May 20; U. of Md. Res. Farm, C. Park - May 28
Yields at both locations limited by moisture conditions and to a lesser degree by leaf blight.

Data based on 4-replicate hand-planted field plots.

Response of Corn to Irrigation as Affected by Moisture Deficit, Age of Plants, and Hybrid

R. G. Rothgeb

Department of Agronomy

Purpose and Objective

This is a second-year report on an experiment designed to furnish data relating to response of corn hybrids to timely irrigation on Mattapex Silt loam soil located on the Wye Institute Farm:

1. To determine the effect of time of planting on the need and effectiveness of irrigation
2. To compare hybrids for response to irrigation

Procedure

As in the preceding year on this same test area, 6 hybrids paired for maturity period were included. With regard to growth period, these hybrids were paired as indicated in the yield table below. Due to the poor performance of 38-11xC103 RF in the late maturity pair, it was replaced in 1970 by C103xH84.

Data were obtained for three planting dates: May 6, May 19 and May 29. Each planting was duplicated on the irrigated block and on the non-irrigated block. On each planting date each hybrid was hand-planted in 3-row plots (approx. 60 plants). Cultural practices were uniform over both moisture treatments. Irrigation was done by 4 over-head rotary sprinklers, and was done when stress periods started.

Rainfall and irrigation totals in inches were as follows:

	July	August	Sept. 1-9	Total
Rainfall	1.09	0.82	0.67	2.58
Irrigation	.47	3.73	1.74	5.94

Results

Wye Institute Farm - 1970

Hybrid	Planted May 6			Planted May 19			Planted May 29		
	Ir. Bu/A	No Ir. Bu/A	Dif. Bu/A	Ir. Bu/A	No Ir. Bu/A	Dif. Bu/A	Ir. Bu/A	No Ir. Bu/A	Dif. Bu/A
XL45	105.7	107.3	1.6	94.5	94.5	0	75.9	67.8	8.1
WF9xOH43	99.1*	119.9	20.8	121.6	68.5	53.1	96.8	55.4	41.4
P3306	140.6	129.3	11.3	117.3	58.1	59.2	77.1	61.2	15.9
H55RfxOH43Rf	143.7	117.3	26.4	133.2	78.2	55.0	102.2	69.7	32.5
Crib F.66	136.7	113.5	23.2	111.1	50.7	60.4	92.7	41.0	51.9
C103RfxH84	152.6	110.4	42.2	131.3	72.7	58.6	98.0	38.7	59.3
Av.	129.73	116.28	13.45	118.17	70.45	47.72	90.47	55.63	34.84

* Missing plants

Blight ratings were made for the six hybrids grown on the irrigated plot planted May 29. Score range (1 to 5. 1 least, 5 worst)

XL45	5.0	H55RfxOh43Rf	4.3
WF9xOH43	3.8	Crib Filler	4.5
P3306	5.0	C103RfxH84	3.3

Summary

Rainfall deficiency drastically limited corn yields at this location Irrigation to the extent indicated above increased yields in 16 of the 18 comparisons. Difference in favor of irrigation resulted in 50+ bushels for 5 of the 6 hybrids. Yields of this size would be expected to be profitable.

Leaf blight was damaging in the May 29 planting. All entries were infected, XL45, P3306 and Crib Filler showed somewhat more leaf damage than the others.

Time of irrigation with regard to stage of plant growth and moisture stress was important.

This sort of test, where facilities permit, is highly desirable in evaluating hybrids and in judging the benefit of irrigation.

Grain Sorghum Variety Test

R. G. Rothgeb, R. Mulford, and J. Newcomer
Department of Agronomy

Purpose and Objectives

Grain sorghum is being considered as a cash grain crop, replacing corn for certain specific uses. Little work has been done in the east because this is normally considered a crop adapted to the semi-arid regions of the United States.

Procedures

Four variety tests were planted in late May and early June, using 12 different varieties. Three row plots, 50 feet long were planted. Yield information was obtained from these plantings.

Results

Average yield for several locations of the various varieties tested in the last three years are as follows:

County	Charles	Frederick	Queen Anne's	Wicomico	Worcester
Year's Average	1967-69	1967-69	1969	1970	1967-69
Variety	Bu.	Bu.	Bu.	Bu.	Bu.
ACCO R 1093	91.2	111.7	118.0		97.4
AKS 614	88.9				100.8
Asgrow BRAVIS	89.1		129.4	91.6	98.8
McNair 546	88.9				103.9
Lindsey BR 75			105.8		
Lindsey BR 79				91.6	
Pioneer 828	33.1*	12.6	58.8*		50.4*
Pioneer 866	33.2*	14.2*	51.4*		50.7*
Pioneer XB 899		42.4	94.0		
T.E. Bird A Boo	92.3	123.5	122.6	97.2	87.6
Todd Grain Harvest				82.7	
Frontier 409				83.7	

* Severe bird damage

Summary

Grain sorghum can be grown successfully in Maryland. Yield will be approximately 15% less than corn except when under severe drought or on poor land, then grain sorghum may equal or out-yield corn.

Breeding Soybeans that Respond to Fertilization

J. A. Schillinger and D. F. Bezdicek
Department of Agronomy

Purpose and Objectives

Presently available soybean varieties do not respond to applied fertilizers. This phenomenon has plagued researchers and farmers alike as they both seek to break the apparent soybean yield barrier.

The objectives of this study are (1) to isolate soybean genotypes that will respond to potassium (K), (2) to identify mechanisms within the plants that cause response to K and (3) to incorporate genes for response to K into improved, adapted soybean varieties.

Procedures

During the 1968, 1969 and 1970 growing seasons, approximately 800 genotypes of soybeans were screened for their ability to respond to K. This was accomplished in field studies conducted at the Wye Institute, Queenstown, Maryland. Genotypes were selected that produced significantly more yield in soil treated with high levels of KCl than in areas where no KCl was added.

Results

Six soybean genotypes have produced consistent yield responses to K fertility. Genotypes which respond to K fertility are compared to Lincoln and Cutler varieties which do not respond to K fertility (Table 1). It can be seen in the data that both Lincoln and Cutler produce very little, if any yield response to K. The Kim genotype produced the highest response to K, averaging 78% increase over the three years.

Response was, at least partially, associated with an increase in size of seed for Kim, Hokkaido and PI 31702 genotypes. Table 2 includes data of relative changes in size of seed under two K fertility levels during 1969 and 1970.

Summary

Selections for response to K fertilization have been successful, in that 6 genotypes of soybeans have been isolated that produce higher yields with soil fertilization K. Research on the mechanisms of response and genetic control is in progress.

Table 1. Relative Response in Yield to K among Soybean Genotypes (Bu/A) grown at the Wye Institute.

Variety	1968 NF[1/]	1968 HK[2/]	1969 HK	1970 HK	Average Relative increase in Response
Kim	100	170	156	209	78
Hokkaido	100	183	137	121	47
31702	100	162	110	145	39
Patoka	100	157	122	122	34
Boone	100	134	145	118	32
Illington	100	136	130	112	26
Cutler	100	- -	102	103	2
Lincoln	100	98	108	93	0

1/ NF - Relative value of 100 percent used each year to express yield in area receiving no fertilizer.

2/ HK - Area which received 600#K/Acre in 1968 and 400#K/Acre in subsequent years.

Table 2. Relative Response as indicated by Seed Size to K among Soybean Genotypes grown under Field Conditions at Wye Institute.

Variety	1969		1970	Average Relative Increase in Response
	NF[1/]	HK	HK	
Kim	100	111	119	+15
Hokkaido	100	113	104	+ 8
31702	100	111	115	+13
Patoka	100	107	96	+ 2
Boone	100	106	96	+ 1
Illington	100	102	91	- 4
Cutler	100	111	96	+ 4
Lincoln	100	102	97	0

[1/] NF - Relative value of 100 used each year.

Comparison of Methods of Planting Soybeans and Sorghum after Barley

J. A. Schillinger, L. Smith
R. Mulford and T. Blaney
Department of Agronomy

Purpose and Objectives

The production of a second crop, usually soybeans, after small grains has been usually through conventional tillage methods. Much interest in recent years has been shown in tillage systems using new no-tillage planters. However, few studies of the advantages and disadvantages of no-tillage practices of planting soybeans have been made. Also, cost comparisons of production of soybeans vs. sorghum after small grains have not been reported.

The objectives of this study were (1) to determine soybean production after barley under 3 methods of planting and to (2) compare economic returns per acre for soybeans or sorghum when planted after barley.

Procedures

Barley was seeded at Quantico, Queenstown, and Clarksville during the fall of 1969. After the barley was harvested, the land was prepared in the following treatments:

1. Conventional tillage - 30 inch rows.
2. Conventional tillage - 7 inch rows.
3. No-tillage - 20 inch rows.
4. No-tillage (sorghum) - 20 inch rows.

Four replications of each treatment were used and the experiment design was randomized complete blocks.

Results

The results of 1970 are presented in Table 1.

Yields varied for each method of planting at each location. The no-tillage method of planting produced the highest yield at Clarksville, but the lowest yield at Queenstown. Averaged over all locations, the yields for each method of planting were similar.

Soybeans produced a greater economic return per acre at the two locations where the two crops were both grown. The difference can be seen in the values in Table 2 which were averaged from the two locations.

However, return from sorghum was similar to soybeans at Queenstown, where severe drought limited soybean growth during August.

Summary

On the basis of one year's results, the no-tillage method of planting appears to be comparable to conventional methods of planting. However, there is a soil type (or soil condition) interaction that during some years adversely affects soybean production in no-tillage plantings. The Wye Institute treatments of no-till in 1970 illustrates this phenomenon. Soybeans seem to have a slight edge in economic returns per acre over sorghum.

Table 1. Yield of soybeans after barley when planted by three different cultural practices.

Location	Variety	Yield, Bushels/Acre		
		Conventional		No-Till
		7"	30"	20"
Clarksville	Calland Soybean	29.6	25.2	34.6
Queenstown	York Soybean	29.8	27.9	22.3
	Bird-A-Boo	- -	- -	60.4
Quantico	York Soybean	36.2	40.4	39.1
	Sorghum	- -	- -	72.4
Average for Soybeans:		31.9	31.2	32.0

Table 2. Comparative cost of production and relative return per acre of soybeans and sorghum planted after barley.

				Return - $/Acre	
	Cost	Yield (Bu/A)	Value /Bu	Gross	Net
Soybeans	40	32.8	2.60	75.28	35.28
Sorghum	47	66.4	1.20	79.68	32.68

1/ Estimated total cost of growing soybeans and sorghum.

2/ Based on November 1st, 1970 prices.

More Effective Use of Soil and Fertilizer Nitrogen

J. H. Axley and J. O. Legg
Department of Agronomy and ARS, U. S. D. A.

Purpose and Objectives

The objective of this study is to determine the fate of nitrogen and particularly nitrate nitrogen in soils as affected by environmental factors.

Procedures

The development of micro ^{15}N plots of 1 x 1 ft. size to determine the fate of nitrogen in corn fields has been successful in reference to the plant uptake of nitrogen. The use of these plots for soils information has been questioned in that the ^{15}N could move laterally in the soil. If this does occur, the amount of ^{15}N in the soil directly under the 1 x 1 ft. treatment area would be reduced. Such results would suggest a greater nitrogen loss than occurred.

To test the loss of nitrogen from micro plots and to determine loss of N from soils, an experiment consisting of 0, 100 and 200 lbs./acre nitrogen application in 3 foot circles was used. This experiment involved ^{14}N tagged with ^{15}N to quantify the results.

Results

The plant tests confirm previous findings that about 50% of the applied nitrogen can be accounted for at the end of the growing season in both the soil and the plant (Table 1). The other 50% has been lost and seemingly not to the ground water. In the Othello soil the carry-over of nitrogen seems to be limited.

Table 1. Fate of nitrogen in Othello soil by use of 1' x 1' plots.

Nitrogen balance table for a 240 lb. nitrogen fertilizer application to a corn crop.

N in Soil % of that applied	+	N in Plant % of that applied	=	N Found % of that applied	or	N Lost % of that applied
27.98		19.14		47.12		52.88

Nitrogen blance table for a 30 lb. application of nitrogen fertilizer to a corn crop.

N in Soil % of that applied	+	N in Plant % of that applied	=	N Found % of that applied	or	N Lost % of that applied
13.00		49.16		52.16		47.84

Summary

These and previous experiments indicate that fertilizer N applied to coastal plain soils in excess of that needed or used by plants is dissipated to the atmosphere as elemental nitrogen via the denitrification route. Although only a few soils have been studied, it would seem that the passage of appreciable quantities of fertilizer nitrogen through these soils to ground waters would be the exception rather than the rule.

Developing, Improving, and Calibrating Soil Tests

J. H. Axley, E. A. Woolson and P. C. Kearney
Department of Agronomy and U.S.D.A.

Purpose and Objectives

1. Developing, improving and calibrating arsenic soil tests.
2. Studying the chemistry of arsenic in soils.

Procedure

The chemistry of arsenic in soils was studied by identifying the chemical forms of arsenic in Maryland soils as well as soils from seven other states. The method of fractionating soil phosphates as proposed by Chang and Jackson and modified by others was converted to an arsenic fractionation method by Woolson, Axley and Kearney. Also several soil testing methods which are commonly used were evaluated.

Results

Four methods of determining the toxicity of As in soils were found to be about equally good. These were:

1. Method now in use in the Soil Testing Laboratory
2. The 0.5N $NaHCO_3$ method
3. A combination of 1 and 2
4. A method developed in this laboratory which assigns efficiency factors to aluminum, calcium and iron arsenic fractions in the soil

Two methods which were less satisfactory were the total arsenic method and the summation of the arsenic fractions method without the use of the efficiency factors.

Arsenic was found to accumulate as iron, aluminum and calcium compounds. If soils are low in these three components, arsenic may be leached from them. The Phytotoxicity of arsenic in soils depends on the chemical form it is in.

Water soluble forms such as sodium arsenate are the most toxic, iron is the least toxic, and calcium and aluminum forms are intermediate in toxicity. Some soils have higher levels of "reactive" aluminum than others. Such soils can better accommodate plants after heavy applications of arsenic (Table 1).

Table 1. The influence of "reactive" aluminum content of soils on corn growth when 6000 ppm of arsenic was added as NaH_2AsO_4

Soil	Plant Growth	Reactive Aluminum
1 - Colton, L.S.	74	51.1
2 - Colton, L.S.	68	39.4
3 - Colton, L.S.	64	30.4
4 - Colton, L.S.	28	33.2
5 - Colton, L.S.	27	29.7
6 - Colton, L.S.	25	23.7
7 - Lockport, SiCl	22	13.5
8 - Dunkirk, F.S.	14	10.2
9 - Colton, L.S.	3	9.8
10 - Hagerstown, C.L.	0	2.9
11 - Lakeland, F.S.	0	1.5

Summary

1. The soil extraction solution presently in use by the Maryland Soil Testing Laboratory is satisfactory for the determination of toxic arsenic presence in Maryland soils.

2. Soil containing an abundance of reactive aluminum can tolerate more arsenic than those with less reactive aluminum before plants are poisoned by arsenic.

The Response of Corn to Fall versus Spring Plowing and Fertilization when Treated with Urea and Nitrate of Soda

V.A. Bandel
Department of Agronomy

Purpose and Objectives

The objectives of this experiment are to compare the effects of the following variables upon corn yields and nutrient recovery: 1) fall versus spring plow-down of urea and nitrate of soda. 2) fall plowing versus spring plowing. 3) several rates of urea plowed down in the fall and in the spring. 4) nitrate of soda versus urea plowed down in the fall and in the spring.

Procedure

This project was conducted at four locations--1) Wye Institute, Queenstown 2) Worcester Vocational Center, Snow Hill 3) George Redman farm, Chestertown, and 4) Plant Research Farm, Fairland. The soil type at each location was Bertie silt loam, Matapeake loam, Butlertown loam and Beltsville silt loam, respectively. Two sources of nitrogen (urea and nitrate of soda) in a complete fertilizer, were broadcast and plowed down in a replicated split-plot design. The subplots within each main plot included urea at rates of 0, 55, 110, and 154 lbs N/A, and nitrate of soda at 110 lbs N/A. Phosphate (P_2O_5) and potash (K_2O) were applied uniformly to all plots at a rate of 120 lbs/A. All plots received a small uniform starter fertilizer application in the row at the time of planting. The fall applied fertilizer was broadcast soon after the corn had been harvested. This normally occurred in late October or early November. The spring fertilizer was applied in late March or early April.

Results

The grain yields obtained at the four locations are given in Tables I, II, III, and IV. At no location was there any significant difference in yields between fall and spring applications of nitrogen. However, in most cases, there was a trend which indicated the possibility of some nitrogen loss due to fall application. For instance, at the Wye Institute in Queen Anne's county,

when all treatments were averaged, the fall fertilization plots yielded 110.1 bu/A and the spring fertilization plots yielded only 114.7 bu/A. This was not a significant difference. However, urea applied at 110 lb N/A yielded 122.9 bu/A when applied in the spring as compared to only 115.4 bu. when applied in the fall. At 165 lb. N/A from urea in the spring, the yields were 129.4 bu. as compared to 110.4 bu/A from the fall application. Similarly, at the 110 lb. N/A from nitrate of soda, the spring application yielded 123.2 bu/A and the fall application, 112.7. This indicates some yield reduction due to possible nitrogen loss from the fall application. This indicates that on some soils there may be some advantage to fall plowing. At three of the four locations, a significant response to nitrogen occurred with 55 lb. N/A. Nitrogen rates in excess of this did not significantly increase corn yields. At the Redman farm in Kent county (Table 4) near Chestertown, 110 lb. N/A was necessary for a significant yield response over the check.

Summary

On the average, corn yields were not significantly reduced by fall applications of a complete fertilizer containing nitrogen, although there is a trend which indicates a response may occur in the future. In 1969, the first year of these tests, no response whatsoever occurred on these locations. Apparently, residual soil nitrogen breaking down and becoming available to the plant, masked the yield effect of any nitrogen loss from leaching. The results of these tests have not indicated significant differences between nitrate of soda and urea as sources of nitrogen for corn. This test will be conducted for at least three consecutive years on the same plot areas in an effort to deplete residual soil nitrogen so that nitrogen responses can be more readily detected by grain yield and nutrient recovery.

Table 1. Influence of Nitrogen Rate, Source and Time of Application on Corn Grain Yields at Wye Institute. 1969-70

Fertilizer Plow-Down Time	N-lb./A					
	0	55	110	165	110[1/]	Ave.[2/]
	Bu/A (15.5% H_2O)					
Fall	98.3	113.9	115.4	110.4	112.7	110.1
Spring	87.9	110.2	112.9	129.4	123.2	114.7
Average[3/]	93.1	112.1	119.2	119.9	117.9	112.4

1/ N from nitrate of soda this treatment only. N from urea all other plots.

2/ No significant difference between fall and spring applications

3/ Least significant difference (5% level)= 11.7 Bu. (difference necessary for treatments to be different from one another).

Table 2. Influence of Nitrogen Rate, Source and Time of Application on Corn Grain Yields at Plant Research Farm - Montgomery Co. 1969-70.

Fertilizer Plow-Down Time	N-lb./A					
	0	55	110	165	110[1/]	Ave.[2/]
	Bu/A (15.5% H_2O)					
Fall	63.5	97.6	91.2	93.6	90.7	87.3
Spring	56.6	98.0	97.0	99.0	105.6	91.2
Average[3/]	60.1	97.8	94.1	96.3	98.2	89.3

1/ N from nitrate of soda this treatment only. N from urea all other plots.

2/ No significant difference between fall and spring applications.

3/ Least significant difference (5% level)= 9.0 Bu. (difference necessary for any treatments to be different from one another).

Table 3. Influence of Nitrogen Rate, Source and Time of Application on Corn Grain Yields at Worcester Vocational Center. 1969-70.

Fertilizer Plow-Down Time	N-lb/A					
	0	55	110	165	110[1/]	Ave.[2/]
	Bu/A (15.5% H_2O)					
Fall	109.7	131.7	120.9	127.4	129.4	123.8
Spring	112.2	132.1	127.0	121.2	132.1	124.9
Average[3/]	110.9	131.9	123.9	124.3	130.7	124.4

1/ N from nitrate of soda this treatment only. N from urea all other plots.

2/ No significant difference between fall and spring applications.

3/ Least significant difference (5% level)=12.8 Bu. (difference necessary for any two treatments to be different from one another).

Table 4. Influence of Nitrogen Rate, Source and Time of Application on Corn Grain Yields at George Redman Farm. 1969-70.

Fertilizer Plow-Down Time	N-lb/A					
	0	55	110	165	110[1/]	Ave.[2/]
	Bu/A (15.5% H_2O)					
Fall	96.8	97.9	107.3	104.6	100.3	101.4
Spring	98.5	107.4	108.0	111.4	101.1	105.3
Average[3/]	97.6	102.7	107.6	108.0	100.7	103.3

1/ N from nitrate of soda this treatment only. N from urea all other plots.

2/ No significant difference between fall and spring applications.

3/ Least significant difference (5% level)= 5.7 Bu. (difference necessary for any two treatments to be different from one another).

Soil Test - Plant Analysis Correlation

V.A. Bandel
Department of Agronomy

Purpose and Objectives

Obviously, almost anyone who has a little knowledge of chemistry and access to the proper chemical reagents can perform a soil test or a plant analysis. However, many amateur soil and plant "doctors" find it difficult to understand that the results are valueless as far as making lime and fertilizer recommendations are concerned, so long as the results have not been properly correlated with plant response. The objectives of this experiment are to 1) observe the effects of nitrogen fertilization on corn yields, percent nitrogen in the plant, and soil pH 2) observe the effects of phosphorus fertilization on corn yields, phosphorus content of the plant, and phosphorus soil test level 3) to observe the effect of potassium fertilization on corn yield, potassium content of the plant, and soil test potassium level, and 4) correlate soil test and plant analysis results with yield, and utilize the results as the basis for improved lime and fertilizer recommendations.

Procedure

This project was conducted on a Bertie silt loam soil at the Wye Institute, Queenstown, Maryland. In three separate tests, replicated four times, fertilizer was applied in the spring before plowing. Plow-down treatments were as follows:

(lb./A N-P_2O_5-K_2O)

Nitrogen test	Phosphorus test	Potash test
0-160-160	170-0-150	170-100-0
30-160-160	170-20-150	170-100-20
60-160-160	170-40-150	170-100-40
120-160-160	170-80-150	170-100-80
240-160-160	170-160-150	170-100-160

Corn was planted uniformly in thirty inch rows with a small amount of starter fertilizer (10-20-20) in the row. Ear leaf samples were taken at tasselling. Following the grain harvest, a soil sample was taken from each plot in late

October or early November. On the four nitrogen check plots, soil samples were taken once a month.

Results

In 1970, it was observed that soil pH's on the nitrogen check plots had dropped an average of about 0.2 of a unit from 1969 (Table 1). Also, as in past years, the higher the nitrogen treatment, the lower the soil pH. This is normal since nitrification of nitrogen fertilizers will normally lower soil pH. Corn ear leaf nitrogen contents increased with nitrogen treatment from 1.4% to 3.2%. Yields increased about 30 bu/A with the addition of 30 lb. of nitrogen per acre. There was no significant further increase in yields with additional increases in nitrogen content. This work indicated that in this case, an ear leaf nitrogen level of about 2.1% or better was adequate for maximum yields. This is somewhat lower than the 2.7 - 3.5% currently being used as a normal range for interpreting plant analysis results.

Increasing the phosphorus fertilization rate tended to increase soil test phosphorus levels (Table 2). However, there was very little effect on ear leaf phosphorus content and no effect upon grain yield. Ear leaf phosphorus percentages ranged from 0.34 to 0.37%. This falls within the 0.25-0.40% phosphorus range considered normal when interpreting corn ear leaf analysis results.

Increasing potassium fertilization treatments tended to increase soil potassium levels and ear leaf potassium contents (Table 2). Ear leaf potassium ranged from 1.8-2.3%, which compares well with the 1.8-2.5% currently considered to be the normal range. Potassium fertilization levels, however, had no significant effect upon corn grain yields.

Summary

Nitrogen fertilization at a rate of 30-60 lb N/A increased corn grain yields. Nitrogen also increased ear leaf nitrogen and reduced soil pH. Phosphorus fertilization increased soil phosphorus levels, but had little or no effect upon ear leaf phosphorus or corn grain yields. Potassium fertilization

increased soil potassium levels as well as ear leaf potassium, but had no effect upon grain yield. Apparently, corn growing on soils having medium phosphorus and potassium soil test levels are not likely to respond significantly to additional applications of phosphorus and potassium. These tests will be continued for several more years in an effort to reduce residual soil fertility levels and to better correlate soil test and plant analysis results with plant response.

Table 1. Influence of Nitrogen Rate on Soil pH, Corn Ear Leaf Nitrogen Content and Grain Yields. 1970.

	Nitrogen Rate (lb/A)				
	0	30	60	120	240
Soil pH	5.9	5.7	5.8	5.7	5.4
Ear Leaf N-%	1.4	2.1	2.1	2.8	3.2
Grain Yield - Bu/A	72.9	102.7	107.8	106.0	109.8

Table 2. Influence of Phosphorus and Potash Rates on Available Soil Phosphorus and Potash, Corn Ear Leaf Phosphorus and Potassium Content, and Grain Yields. 1970.

	P_2O_5 and K_2O Rate (lb/A)				
	0	20	40	80	160
Soil P_2O_5 - lb/A[1/]	126 M	129 M	151 H	190 H	225 H
Ear Leaf P - %	0.34	0.36	0.37	0.37	0.37
Grain Yield - Bu/A	103.3	108.4	113.2	117.2	106.5
Soil K_2O - lb/A[1/]	112 M	118 M	140 M	148 M	248 H
Ear Leaf K - %	1.8	2.0	2.2	2.2	2.3
Grain Yield - Bu/A	106.6	110.8	110.4	118.6	109.3

1/ As determined after extraction with 0.05 NHCl and 0.025 NH_2SO_4.

Nitrogen Topdressing of Malting Barley

V. A. Bandel
Department of Agronomy

Purpose and Objectives

The production of barley in Maryland for malting purposes is relatively new. Tschermak barley, currently the only variety being grown for the malting industry, is also new to the state. Information is needed by the growers on how to fertilize Tschermak malting barley so that maximum yields can be obtained with the most efficient rates of nitrogen fertilization. Since Tschermak is very susceptible to lodging, it is essential to determine the safe nitrogen level below which the small grain will not lodge. Also, grain protein levels are critical in malt barley. It is essential that we determine the maximum nitrogen level that can be applied to Tschermak without increasing the grain protein levels to an unacceptable level. Therefore, the objectives of this experiment were 1) to determine nitrogen topdressing levels at which maximum grain yields and maximum profits would be obtained 2) to determine maximum nitrogen levels where serious lodging would not occur, and 3) to determine maximum nitrogen levels where grain protein contents were not increased to unacceptable levels.

Procedure

These tests were conducted on private farms at seven locations in Dorchester, Charles, Cecil, Kent, Caroline, Howard, and Queen Anne's counties. The test locations were selected from farms on which Tschermak barley had been seeded the previous fall. The nitrogen was topdressed in the early spring (late February or early March). Ammonium nitrate was used as the nitrogen source. Rates of nitrogen topdressed were 0, 20, 40, 60, and 100 lbs./A. The plots were harvested with a small plot combine in June. Grain yields were calculated at 14% moisture and 48 lb./bu. Grain protein was

determined by multiplying percent Kjeldahl nitrogen by 6.25.

Results

In general the results indicate that Tschermak barley should be topdressed according to guidelines set forth in Extension Fact Sheet No. 210 entitled "Nitrogen Topdressing of Small Grains". Tschermak barley is very susceptible to lodging (similar to Wong and Pennrad). For maximum yields, Tschermak should be topdressed in the spring with no more than 20-40 lbs./A of nitrogen (see Table 1). Some fields were sufficiently fertile that they should not be topdressed with additional nitrogen. The grain yields at the Dorchester county location were drastically reduced by a very severe infestation of army worms. At the Queen Anne's location, yields were reduced severely by very serious lodging. The grain protein levels were not significantly increased by normal topdressing rates (20-40 lb. N/A) on soil that demonstrated a response to nitrogen topdressing. (Table 2). The profit or loss from top-dressing Tschermak barley with nitrogen is given in Table 3. Obviously there is tremendous variation in the response from one location to another, but on the average, those fields that should be topdressed should receive no more than 20 to 40 lbs./A of nitrogen for maximum yields and highest profit per acre.

Summary

In general, when topdressing Tschermak malting barley, the amount of nitrogen to use should be determined according to the guidelines set forth in Extension Fact Sheet No. 210, entitled "Nitrogen Topdressing of Small Grains". On fields that should be topdressed, no more than 20 to 40 lbs./A of nitrogen should be applied. These nitrogen rates applied where recommended do not seem to generally increase grain protein levels to unacceptable levels.

Table I. Grain Yield of Tschermak Barley as Influenced by Nitrogen Topdressing. 1970.

County	N (lb/A) 0	20	40	60	100	LSD .05 [4/]
	Bu/A [1/]					
Dorchester [2/]	54.5	40.3	35.3	26.2	20.7	18.9
Charles	70.6	72.1	74.6	60.1	56.5	----
Cecil	52.4	73.6	73.1	70.6	81.2	----
Kent	51.9	58.0	68.1	67.1	70.1	13.6
Caroline	40.8	61.5	69.1	69.6	71.6	14.8
Howard	64.6	71.6	67.0	69.3	68.2	----
Queen Anne's	59.8	51.1	43.7	42.4	36.3	11.0
Average	56.4	61.2	61.6	58.0	57.8	

1/ Uncleaned grain at 14% moisture and 48 lb./bushel.

2/ Yields reduced by severe army worm infestation.

3/ Yields reduced by severe lodging.

4/ Least significant difference. If yield difference between two treatments does not equal or exceed LSD, yields are not different. If LSD is not given, nitrogen treatments had no significant effect on yields.

Table 2. Grain Protein Content of Tschermak Barley as Influenced by Nitrogen Topdressing. 1970.

County	N (lb/A) 0	20	40	60	100	LSD .05 2/
	% Protein 1/					
Dorchester	9.6	10.2	12.2	12.2	17.2	2.2
Charles	8.9	10.6	10.8	12.6	13.4	---
Cecil	10.3	10.2	9.4	11.6	12.4	---
Kent	9.0	8.5	8.6	10.5	11.7	1.7
Caroline	9.5	8.6	9.0	8.9	13.5	1.7
Howard	11.7	12.5	12.4	11.4	13.3	---
Queen Anne's	11.3	15.2	16.6	16.1	16.5	2.1
Average	10.0	10.8	11.3	11.9	14.0	

1/ % protein calculated by multiplying %N x 6.25

2/ Least significant difference. If percent protein difference between two treatments does not equal or exceed LSD, yields are not different. If LSD is not given, nitrogen treatments had no significant effect on protein content of grain.

Table 3. Profit or Loss[1/] from Tschermak Barley as Influenced by Nitrogen Topdressing. 1970.

County	N (lb/A)				
	0	20	40	60	100
	$/Acre[2/]				
Dorchester	0.00	-19.74	-28.00	-41.37	-52.24
Charles	0.00	- 0.12	11.00	-18.00	-27.63
Cecil	0.00	24.50	21.88	16.75	26.00
Kent	0.00	5.62	16.24	13.00	12.74
Caroline	0.00	23.88	31.38	30.00	28.50
Howard	0.00	6.75	- 1.00	- 0.12	- 5.50
Queen Anne's	0.00	-12.87	-24.13	-27.75	-39.37
Average	0.00	4.00	2.48	- 3.93	- 8.21

1/ Dollars/acre compared to 0 - N treatment.

2/ Based upon barley @ $1.25/bu., N @ $0.10/lb., P_2O_5 @ $0.08/lb., and K_2O @ $0.04/lb.

Leaching of Nitrate Nitrogen from Several Fertilizer Sources When Applied to Soils of Various Textures

V.A. Bandel and C.E. Rivard
Department of Agronomy

Purpose and Objectives

1. To compare the effect of rate and time of application of sulfur-coated urea and several other forms of nitrogen on growth and yield of small grains on light textured soils.
2. To compare residual effects of sulfur-coated-urea and other nitrogen forms for corn production.
3. To determine relative leaching losses of sulfur-coated-urea and other nitrogen forms on various textured soils.

Procedures

SMALL GRAINS. A 3 x 6 randomized factorial design was replicated four (4) times. Sulfur-coated-urea, ammonium nitrate, and urea were applied at 60 lb. N/A. A no nitrogen plot was included for each source as a check, and the remaining plots were given a nitrogen application at one of five dates spaced approximately five weeks apart through the season. Blueboy wheat was used as the test crop at the Poplar Hill and Plant Research farms in the 1969-70 and 1970-71 seasons and Barsoy barley was used at the Forage farm in the 1970-71 season. The soil types Galestown loamy sand, Beltsville silt loam, and Chester silt loam at the Poplar Hill, Plant Research, and Forage Research Farms respectively.

CORN. A 3 x 5 randomized factorial design was replicated four times at the Wye Institute and at the Poplar Hill farm on a Bertie silt loam and a Galestown loamy sand respectively. The above three nitrogen sources were applied and plowed down at 0, 60, 120, 240, or 480 lbs. of nitrogen per acre. The corn variety Pioneer 3369A was used for the test crop at both locations. Whole

plant and soil samples were taken when the corn was 24 inches tall. Ear leaf samples were taken at the tasselling stage, and soil samples were taken again after harvest. All plant samples were tested for total N, P, K, Ca, and Mg, using the University of Maryland Soil Testing Laboratory facilities (ref. Agronomy Mimeo No. 53). Soil samples were taken to a depth of 48 inches in 6 inch increments, and tested for nitrate nitrogen using an automated technique.[1/] Grain yields were determined by harvesting the center two rows of the six row plots. Statistical analysis of the data was done using the UNIVAC 1108 computer at the University of Maryland Computer Science Center. Free computer time is gratefully acknowledge.

Results

SMALL GRAINS. Wheat yields at the Poplar Hill farm and grain nitrogen concentrations are given in Table 1. Plots receiving sulfur-coated-urea consistently produced lower yields than plots receiving ammonium nitrate on the same application dates. Yields from regular urea treatments were erratic from one application date to the next. Average yields for urea and ammonium nitrate were 49 bu./A and only 42 bu./A for sulfur-coated-urea. Greater nitrogen concentrations in the grain were found when the fertilizer was applied in late winter as opposed to fall. There were no differences in grain levels due to differences in sources.

Wheat stands were poor at the Plant Research farm due to winter killing during the 1969-70 season. The wheat was planted somewhat earlier in 1970 in hopes of preventing winter killing in the 1970-71 season.

CORN. Dry weather adversely affected corn yields at both locations, and a severe thunderstorm with high winds occurred at the Wye Institute about two weeks before harvest. The resulting yields at the Wye Institute were quite

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1/ Personal communication with Dr. J. E. Steckel, Rutgers University, New Brunswick, N.J.

variable, and differences between treatments could not be determined. Differences between application rates were significant at the Poplar Hill farm, but not between sources, as shown in Table 2.

Ear leaf analysis at the tasselling stage (Table 2) also indicated that significant differences in N content were detectable between application rates but not between sources. Low nitrogen levels in the leaves appeared to correlate well with the lower yields from plots which received no nitrogen.

Summary

Sulfur-coated-urea, ammonium nitrate and urea were compared topdressed on wheat and plowed down on corn. A time of application study on wheat indicated that yields were not significantly higher when topdress N was applied in early spring as compared to fall and winter. But there was a trend indicating slightly higher yields from the spring application and possible N loss from the soluble sources applied in the fall. Lower yields resulting from the sulfur-coated-urea treatments indicated that N release rates from this slow-release fertilizer were insufficient for maximum yields at the 60 lbs. N/A application rate.

Yields and ear leaf N concentrations indicated that there was no difference between the three nitrogen sources when applied to corn. Grain yields reached a maximum when 120 lbs. of N were applied per acre. Ear leaf N levels continued to increase even for the 240 and 480 lb. treatments, indicating luxury consumption at these high rates. Leaf N levels and grain yields increased considerably from the 0 to 60 lb. treatments. The increase of about 7 bu./A between the 60 and 120 lb. treatments was accompanied by only a 0.1% N increase in the ear leaves.

Table 1. Influence of Source of Nitrogen and Time of Application on Blueboy Wheat Yields and Total Nitrogen Content of the Grain at Poplar Hill Farm. 1970.

Source	Check	Oct.9	Nov.11	Dec.18	Jan.21	Feb.27	Average
				Bu/A			
SCU	32.8	40.2	39.1	49.6	41.3	49.6	42.1
AN	41.5	45.9	43.7	53.5	48.0	59.0	48.6
Urea	38.6	51.1	55.8	45.5	54.8	48.3	49.0
Average	37.6	45.8	46.2	49.5	48.0	52.3	46.6
				%N			
SCU	1.8	2.0	1.8	1.9	1.9	2.1	1.9
AN	1.6	1.7	1.8	2.0	2.0	2.0	1.9
Urea	1.8	1.9	1.9	2.0	2.0	2.1	1.9
Average	1.8	1.9	1.8	2.0	2.0	2.1	1.9

Table 2. Corn Grain Yields and Nitrogen Content of Ear Leaves at the Poplar Hill Farm. 1970.

Source	0	60	120	240	480	Ave.
			Bu/A			
SCU	90.5	114.8	109.0	114.8	118.0	109.4
AN	91.5	107.3	122.5	115.3	108.8	109.1
Urea	85.3	110.3	122.5	117.3	118.3	110.7
Average	89.1	110.8	118.0	115.8	115.0	109.7
			%N			
SCU	2.5	3.1	3.1	3.4	3.7	3.2
AN	2.5	3.0	3.6	3.5	3.8	3.3
Urea	2.1	3.5	3.3	3.7	3.8	3.3
Average	2.4	3.2	3.3	3.5	3.8	3.2

Effects of Nitrogen Application on Nitrate Movement Under Corn, Fescue and Fallow

D. F. Bezdicek, Department of Agronomy

Purpose and Objectives

The objective of this investigation was to determine to what extent three cropping systems might effect the movement of nitrate nitrogen in the soil profile.

Procedure

Four replications of the following treatments were conducted at the Wye Institute in 1969, 1970 and 1971 on Matapex silt loam: cropping system - corn, fallow and fescue. Nitrogen fertilization - 0, 250, 500, and 1000 lbs. N as ammonium nitrate was applied in the spring. A completely randomized design was used. Soil cores at 1 foot intervals to 5 feet were taken in the fall of 1969 and the spring of 1970 and analyzed for nitrate and total nitrogen.

Results & Discussion

Nitrate data for the spring 1970 and 1971 samplings (prior to spring N application) are shown in Table 1. Results indicate a sharp increase in nitrate at lower horizons from the fall 1969 sampling (data not shown).

Fescue appeared to be the most effective of treatments used in removing fertilizer nitrogen. The fallow treatment appeared to have the greatest nitrate levels under the 500-lb. treatment for both years. Corn and fallow appeared to contain approximately equal nitrate levels at the 500-lb. nitrogen treatment. Nitrate levels under the 500-lb. treatment for corn and fescue are only slightly higher than the (zero-N) treatment.

Table 1. Nitrate levels at various depths from fertilizer nitrogen applied under three cultural practices.

Fertilizer Lbs. N/A as NH_4NO_3	Sampling Depth Inches	PPM Nitrate Nitrogen* Corn 1970	Corn 1971	Fallow 1970	Fallow 1971	Fescue 1970	Fescue 1971
0	0-12	9	4	12	2	8	3
	12-24	12	5	14	4	5	1
	24-36	11	2	10	3	5	1
	36-48	11	6	9	3	4	1
	48-60	10	1	9	5	8	3
250	0-12	10	3	24	2	10	3
	12-24	18	12	22	7	9	5
	24-36	20	15	16	8	7	4
	36-48	12	7	12	10	8	4
	48-60	12	6	12	8	9	3
500	0-12	13	4	22	8	9	2
	12-24	13	7	28	16	9	5
	24-36	15	12	15	17	10	12
	36-48	17	8	14	16	10	8
	48-60	14	8	12	10	9	8
1000	0-12	10	16	26	36	12	2
	12-24	40	39	43	71	36	10
	24-36	35	32	25	31	43	21
	36-48	24	40	20	20	23	22
	48-60	16	26	14	14	15	25

* Nitrate levels expressed on dry soil basis.

Summary

Fescue appeared to be the most effective cropping system studied in removing nitrate from the soil profile. Corn was nearly as efficient in nitrate removal. Soil nitrate levels in the fallow treatment were the highest of treatments studied over all nitrogen application rates.

Effect of Organic Nitrogen on Nitrogen Fixation and Soybean Yield

D. F. Bezdicek and R. F. Mulford
Department of Agronomy

Purpose and Objectives

Inorganic nitrogen applied to soybeans generally reduces nitrogen fixation rate or has a variable effect on soybean yield. Organic nitrogen applied either as fertilizer or plant residues will not reduce nitrogen fixation rate to the extent that inorganic nitrogen does. Studies have suggested that organic nitrogen releases nitrogen more slowly without inhibiting nitrogen fixation. Objectives selected for this investigation were to:

1. Study the effect of rye-applied nitrogen on nitrogen fixation and soybean yield, and
2. Study the effect of fertilization rate and fertilizer source on nitrogen fixation rate and soybean yield.

Procedure

Studies were conducted on Evesboro loamy sand at the Poplar Hill experimental site near Quantico, Maryland. The following treatments were studied in a 2 x 2 x 4 factorial design with four replications.

1. Two fertilizer sources: NH_4NO_3 and urea
2. Fertilizer application at two times: on rye (March) and at planting
3. Four broadcast nitrogen rates: 0, 50, 100, and 200 lbs. N per acre

Four-row plots were planted to Kent soybeans in an area of 10 x 22 ft. Nitrogen fixation rates in August were conducted by removing nodulated roots from 1.5 ft. and subjecting them to the acetylene reduction method. Soybean yield was determined from two 16 ft. rows.

Results

Nitrogen fixation rate (based on ethylene production), nodule data and yield as influenced by nitrogen fertilization rate are shown in Table 1. Soybean yield was not significantly influenced by fertilization rate although yields decreased at higher N rates. Nodule weight and ethylene generally decreased with increased rate of fertilization. Fixation efficiency increased substantially with increase in fertilizer N.

Table 2 shows the average responses when time and source of nitrogen fertilizer are considered. Soybean yield from rye-applied nitrogen was slightly (10% level) higher than from nitrogen applied at planting. Sources of nitrogen did not significantly influence any of the parameters measured.

Summary

Soybean yield was not significantly influenced by either N source or fertilizer application rate. Yield was slightly increased (10% level) by applying N on rye rather than at planting. Nitrogen-fixation rate was reduced by increased fertilizer rate and by fertilizer applied at planting. Fixation efficiency on a unit weight nodule basis was increased by increasing fertilization rate and by applying N directly at planting. More-detailed studies will be conducted in 1971 in order to more effectively assess the influence of rye-applied N on the parameters studied.

Table 1. Fertilization rate, ethylene production, nodule weight, fixation efficiency (ethylene production per unit nodule weight), and soybean yield for soybeans at Poplar Hill.

Fertilization Rate[1/] Lbs N/Acre	N Fixation[2/♀] Rate ul ethylene/hr	Nodule wt[2/*] g	Fixation Efficiency ul ethylene/g/ nodule/hr	Yield bu/A
0	2607	6.7	390	28.3
50	2644	4.4	600	29.3
100	2305	3.9	590	27.3
200	1394	1.4	960	26.3

1/ All data averaged over other treatments.

2/ Per 1.5 ft. of row.

* Significantly different at the 5% level.

♀ Significantly different at the 10% level.

Table 2. Time and source of N fertilizer, ethylene production, nodule weight, fixation efficiency (ethylene production per unit nodule weight), and soybean yield for soybeans at Poplar Hill.

Fertilizer Treatment[1/]	N Fixation[2/] Rate ul ethylene/hr	Nodule wt[2/] g	Fixation Efficiency ul ethylene/g/nodule/hr	Yield bu/A
N on rye	2445	5.3	463	28.9♀
N on planting	2030	3.0	690	26.8♀
NH_4NO_3	2112	4.2	500	27.8
Urea	2361	3.9	590	27.6

1/ All data averaged over other treatments.

2/ Per 1.5 ft. of row.

♀ Significant at the 10% level.

Soybean Yield and Nitrogen Fixation Rate After Sixteen Years of Continuous Corn Under Various Nitrogen Fertilization Practices

D. F. Bezdicek and E. Strickling
Department of Agronomy

Purpose and Objectives

Many researchers have shown the soybean yield is dependent upon good fertility practices conducted on a previous crop such as corn. Continuous corn plots (16 years) at different N fertilizer rates were planted to soybeans in 1970 to determine the influence of rate of nitrogen on soybean yield and nitrogen fixation rate.

Procedure

Continuous corn was planted 16 continuous years on Beltsville silt loam prior to 1970 in plots at the Plant Research farm near College Park, Maryland. Plots were replicated three times with the following treatments:

1. Nitrogen fertilizer rates: 0, 100, and 400 lbs. N/acre as NH_4NO_3 broadcast in the spring prior to planting.
2. Cover crop: cover and no cover established during each fall.

Soybeans (Kent variety) were planted in 1970 in eight-row plots of 22 x 30 ft. Nitrogen fixation rate by the acetylene reduction method was determined from nodulated roots from 1.5 ft. of row. Yields were determined from two 25 ft. rows.

Results

Soybean yield, nitrogen fixation rate (ethylene production), nodule weight, and nitrogen fixation efficiency are shown in Table 1. Soybean yield was not significantly (5% level) influenced by either rate of nitrogen application or cover crop. The highest rate of nitrogen application completely

inhibited nodulation and nitrogen fixation. Nodulation was reduced in the 100-lb. nitrogen treatment as compared with the zero-N treatment. Nitrogen fixation efficiency was increased from the 100-lb. treatment and from a fall-cover crop when compared with the zero-N treatment.

Summary

The effects of 16 years of continuous corn under 0, 100 and 400 lbs. N did not influence the yield of soybeans. Reduction of nitrogen fixation was apparent at the 100-lb. rate with complete inhibition at the 400-lb. rate.

Table 1. Fertilization rate, N fixation rate, nodule weight, fixation efficiency, and soybean yield for 16 year continuous corn study.

Fertilization Rate Lbs. N/A as NH_4NO_3	N Fixation[1/♀] Rate ul ethylene/hr	Nodule wt[1/*] g	Fixation Efficiency ul ethylene/g/ nodule/hr	Yield bu/A
0	106	7.2	39	33.1
100	56	2.1	77	32.8
400	none	none	none	33.6
cover	100	5.9	83	33.2
no cover	63	3.4	32	33.2

1/ Based on 1.5 ft. of row.

* Significant at the 5% level.

♀ Significant at the 10% level.

Vermiculite Determination on Whole-Soil Basis By Cation Exchange Capacity Methods

C.B. Coffman and D.S. Fanning
Department of Agronomy

Purpose and Objectives

This study was initiated to provide information concerning the genesis of soils developed from metabasalt in the Middletown Valley of Maryland.

Previous studies of these soils had indicated a poor correlation between cation exchange capacity (CEC) and clay content. Thus, it appeared that a large portion of the reactive minerals in these soils may exist in the silt fraction rather than in the clay fraction. X-ray diffraction analysis of selected soil horizons indicated vermiculite to be the primary reactive mineral in these soils. Because of the occurrence of vermiculite in several soil fractions, a laboratory method of vermiculite determination on a whole-soil basis was developed.

The vermiculite determination procedure contains certain assumptions. The measurement of fixed potassium (K) in the soil is the basis for the method, and the assumption is that all of the K is fixed by vermiculite. The difference between the calcium exchange capacity (CaEC) in which no fixation is assumed and potassium exchange capacity (KEC) is the measurement of K fixation. The exchange capacity of vermiculite is assumed to be 154 me/100 g.

The procedure has provided useful data for the previously mentioned soil genesis study, and has been found to give good results on various soils developed from a variety of geologic materials.

Procedure

The major soils used in the development of this procedure were developed on metabasalt composed primarily of chlorite but also containing a variety of

other minerals. The geomorphology of the area is composed of rolling hills deeply incised by small streams and creeks. Scattered outcrops of the underlying metabasalt occur throughout the valley.

Soils from other sections of Maryland were also used in the development of this procedure, as well as soils from other states.

The soils were air dried and ground to pass through a 2 mm seive. One-half gram samples were weighed into centrifuge tubes for removal of organic matter and free iron. Separate samples of each soil were saturated with calcium (Ca) or K using neutral acetate salts. Calcium was replaced by centrifuge washing with magnesium acetate. The saturated samples were oven dried at 110° C overnight before replacement of exchangeable K with ammonium acetate washings. Measurements were made of replaced Ca and K and the CaEC and the potassium exchange capacity (KEC) were calculated. Percent vermiculite was determined by this equation:

$$\% \text{ Vr} = \frac{(\text{CaEC, me/100g}) - (\text{KEC, me/100g})}{154 \text{ mg/100g}} \times 100$$

Results

If one can assume that the vermiculite in the soils from the Middletown Valley developed from the degradation of biotite and chlorite of the metabasalt, it would be possible from studying the vermiculite content in the soil profiles to derive information concerning the genesis of these soils. The soils from this area that were studied were higher in vermiculite in the lower horizons and underlying saprolite than in the surface horizons. These data suggest that vermiculite has been weathered to other minerals in the surface horizons.

Field studies of Myersville and Fauquier soils from the Middletown Valley area indicate that Fauquier soils were older; that is, they appear to have undergone greater weathering than Myersville soils. Data presented in Figure 1 seem to confirm this field observation. Two Myersville profiles and one

Fauquier profile at one site were examined by the vermiculite determination procedure. The contribution of vermiculite to the CaEC of the solum of the two Myersville profiles is generally greater than that in the Fauquier profile. The latter profile exhibited field evidence of greater weathering, such as more strongly developed structure in the B horizon, redder hues, and oriented clay skins. X-ray diffraction analysis supports the assumption that a biotite - vermiculite and a chlorite - vermiculite weathering sequence exists as the metabasalt decomposes. A profile containing less vermiculite may indicate a greater degree of weathering, especially when field observations indicate stronger profile development. A possible weathering product of vermiculite in this area is kaolinite, a less reactive and non-fixing clay mineral.

Summary

A laboratory method for the rapid determination of vermiculite on a whole soil basis has been developed. Although this procedure has been found applicable to soils throughout the state, it has been used primarily to study the development of the soils from the Middletown Valley area of Frederick County.

Determination of the vermiculite content of Myersville and Fauquier profiles may contribute to an understanding of the genesis of these soils. Preliminary work has shown an inverse relationship between the vermiculite content of the solum and the degree of soil development. By applying the whole-soil vermiculite determination procedure in conjunction with other investigative techniques it may be possible to determine why there are differences between the Myersville and Fauquier soils.

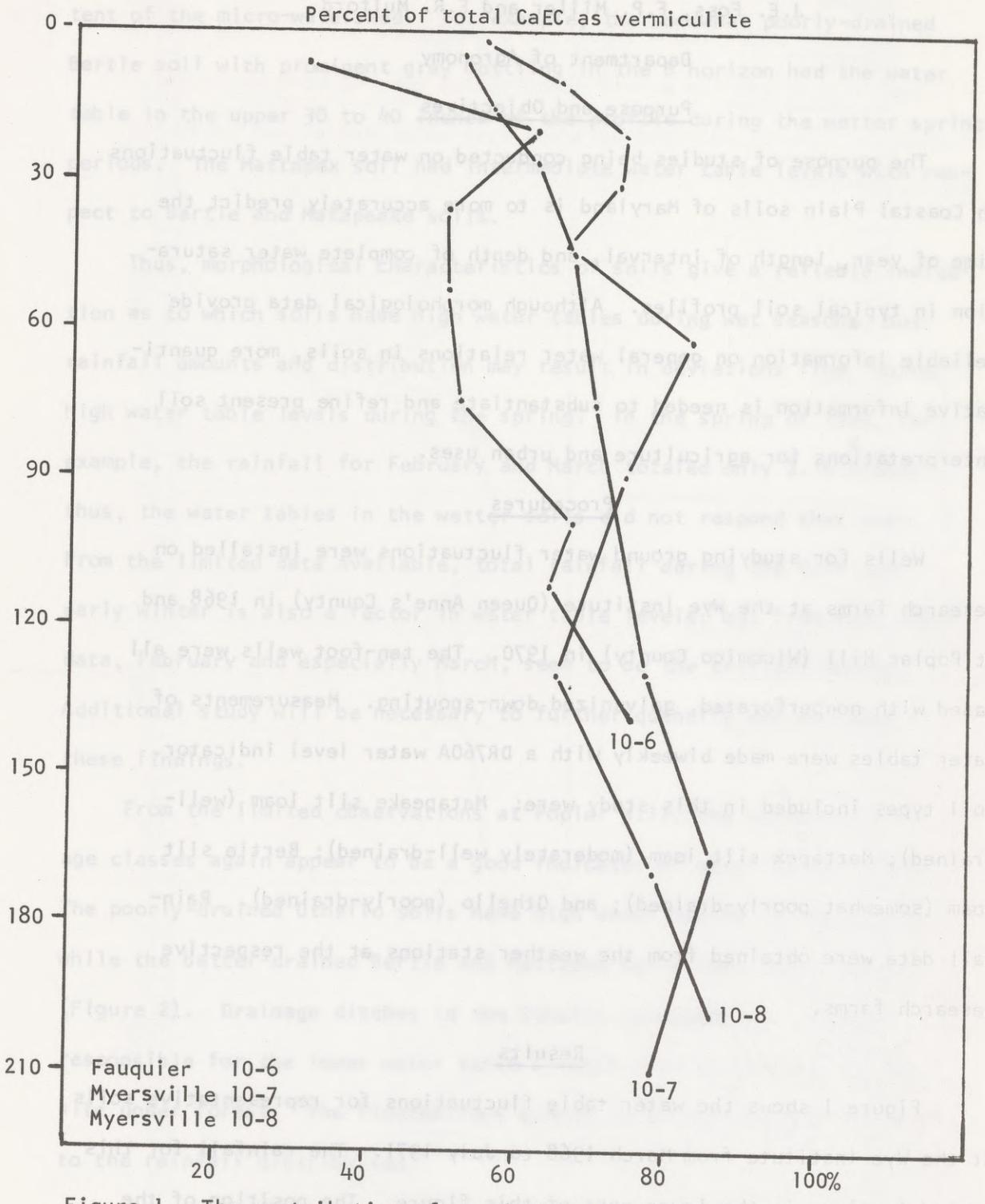

Figure 1. The contribution of vermiculite to the calcium exchange capacity of 2 Myersville profiles and 1 Fauquier profile from the Middletown Valley of Maryland.

Ground Water Table Investigations In Some Coastal Plain Soils of Maryland

J.E. Foss, F.P. Miller and F.R. Mulford

Department of Agronomy

Purpose and Objectives

The purpose of studies being conducted on water table fluctuations in Coastal Plain soils of Maryland is to more accurately predict the time of year, length of interval, and depth of complete water saturation in typical soil profiles. Although morphological data provide reliable information on general water relations in soils, more quantitative information is needed to substantiate and refine present soil interpretations for agriculture and urban uses.

Procedures

Wells for studying ground water fluctuations were installed on research farms at the Wye Institute (Queen Anne's County) in 1968 and at Poplar Hill (Wicomico County) in 1970. The ten-foot wells were all cased with nonperforated, galvanized down-spouting. Measurements of water tables were made biweekly with a DR760A water level indicator. Soil types included in this study were: Matapeake silt loam (well-drained); Mattapex silt loam (moderately well-drained); Bertie silt loam (somewhat poorly-drained); and Othello (poorly-drained). Rainfall data were obtained from the weather stations at the respective research farms.

Results

Figure 1 shows the water table fluctuations for representative soils at the Wye Institute from March 1968 to July 1971. The rainfall for this period is given in the lower part of this figure. The position of the

water table in the soil profiles is directly related to the morphological properties of the soils as modified by topographic position and extent of the micro-watershed. For example, the somewhat poorly-drained Bertie soil with prominent gray mottling in the B horizon had the water table in the upper 30 to 40 inches of the profile during the wetter spring periods. The Mattapex soil had intermediate water table levels with respect to Bertie and Matapeake soils.

Thus, morphological characteristics of soils give a reliable indication as to which soils have high water tables during wet seasons, but rainfall amounts and distribution may result in deviations from "normal" high water table levels during the spring. In the spring of 1969, for example, the rainfall for February and March totaled only 2.16 inches; thus, the water tables in the wetter soils did not respond that year. From the limited data available, total rainfall during the fall and early winter is also a factor in water table levels; but from four years data, February and especially March, seem to be the critical months. Additional study will be necessary to further quantify and validate these findings.

From the limited observations at Poplar Hill, the various drainage classes again appear to be a good indicator of water table levels. The poorly-drained Othello soils have high water tables in the spring, while the better-drained Bertie and Mattapex soils have lower levels (Figure 2). Drainage ditches in the Othello (cropped) are probably responsible for the lower water table in this site as compared to the site under forest. The fluctuations appear to be very closely related to the rainfall distribution.

Summary

Investigations at the Wye Institute and Poplar Hill research farms have shown that the soil drainage class is a good indicator for predicting the overall water table levels in a landscape unit. These studies will continue to provide a more quantitative base to more accurately predict the time of year and duration when water tables may influence land use.

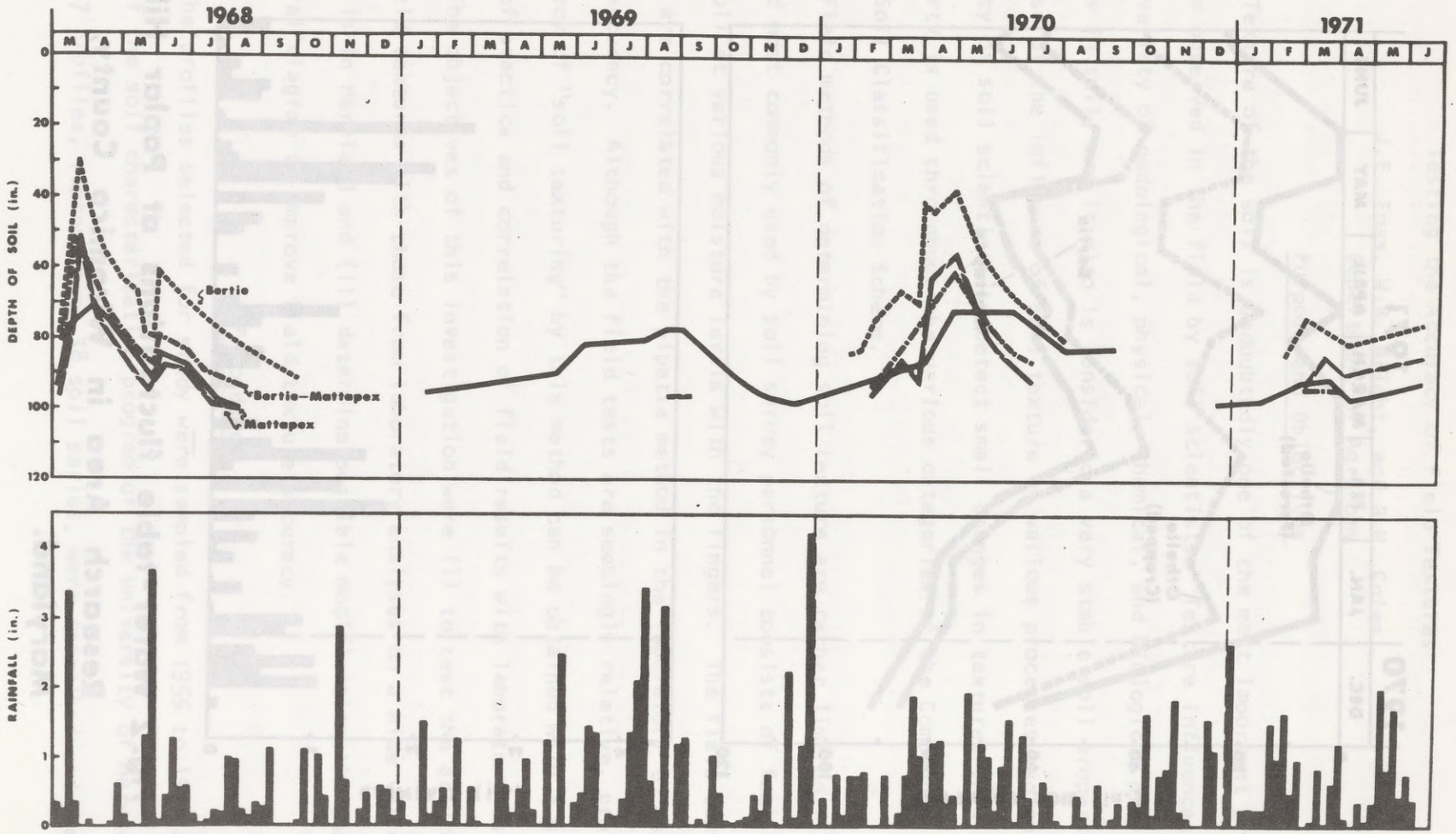

Fig.1 Ground water levels and precipitation at 4 sites, Wye Institute 1968-71

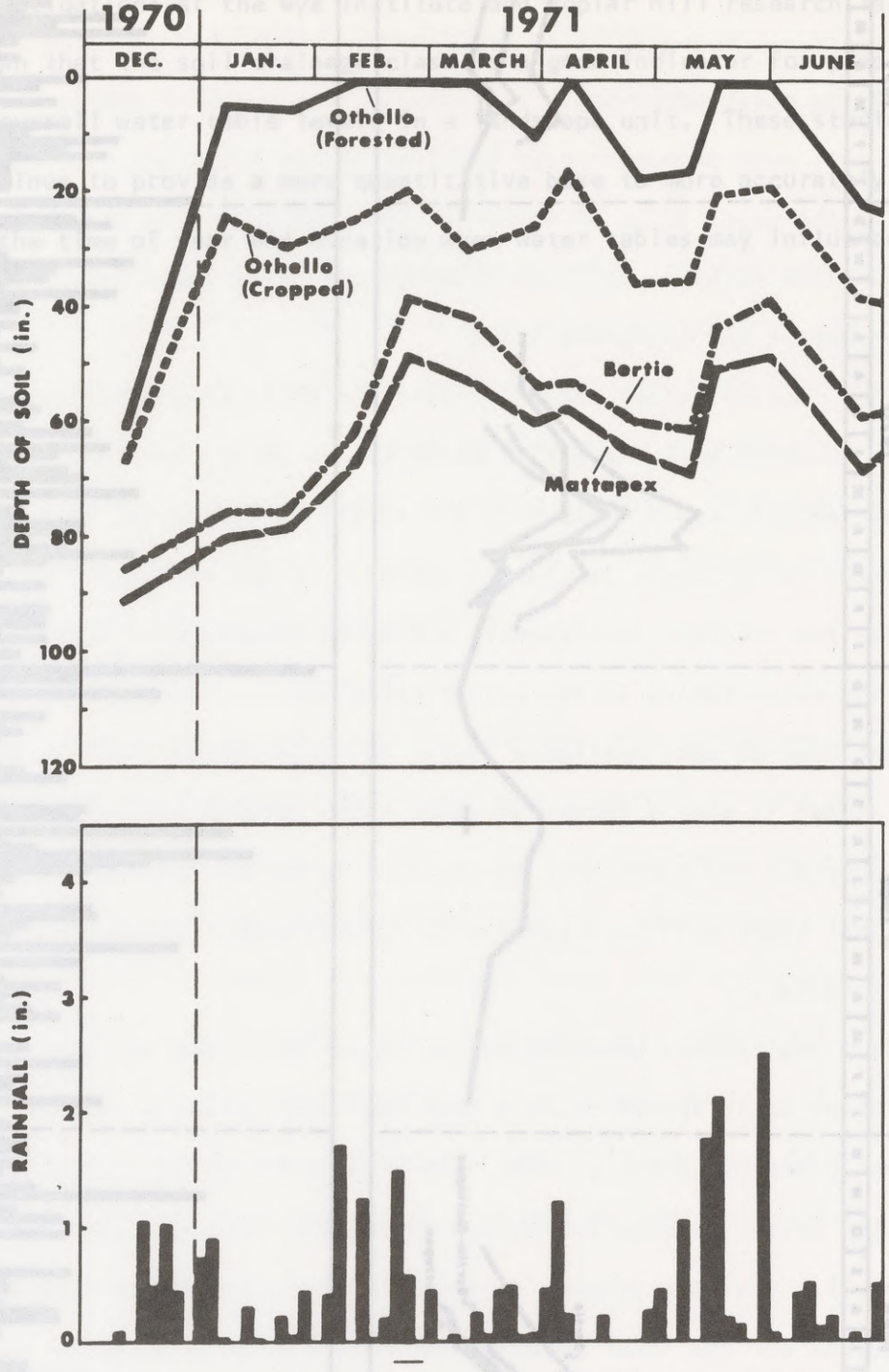

Fig. 2 Water-table fluctuations at Poplar Hill Research Area in Wicomico County, Maryland.

Testing the Accuracy of Field Textures

J.E. Foss, W.R. Wright, and R.H. Coles
Department of Agronomy

Purpose and Objectives

Texture of the soil is undoubtedly one of the most important properties observed in the field by soil scientists. Texture influences a wide variety of pedological, physical, chemical, and biological processes in soil, and it also is considered a very stable soil property. Because of the influence of soil texture on various processes and the ability of soil scientists to detect small changes in texture, this property is used throughout the various categories of the Comprehensive Soil Classification Scheme.

Field methods of determining soil texture are rather limited. The method most commonly used by soil survey personnel consists of feeling the soil at various moisture levels with the fingers. The field textures are correlated with the pipette method in the laboratory to determine accuracy. Although the field tests are seemingly relative, proficiency of "soil texturing" by this method can be obtained with a great deal of practice and correlation of field results with laboratory data.

The objectives of this investigation were (i) to test the accuracy of field textures with those from laboratory analyses on a wide variety of soils in Maryland and (ii) determine possible modifications in the textural diagram to improve field texture accuracy.

Procedures

The profiles selected for study were sampled from 1955 to 1970 as part of the soil characterization program of the University of Maryland. The 127 profiles, representing 38 soil series, were described and sampled

according to procedures outlined in the Soil Survey Manual. Textures were determined under field conditions. Samples were then brought to the laboratory where they were air-dried, crushed, and passed through a ten-mesh sieve to separate the coarse fragments from the less-than-two-mm fraction. Pipette analysis was used to determine the particle size of the soil samples for testing the accuracy of field textures. A UNIVAC 1108 computer system, with a CALCOMP 670 and 565 plotter, was used for drawing the USDA textural diagrams and plotting the various points.

Results

Accuracy of Field Textures

Table 1 shows the percentage agreement of field textures with the laboratory analyses. The overall agreement of 606 samples was 50% and the accuracy of the various textural classes ranged from 18 to 74%. Allowing a four percent tolerance around the particular textural class increased the overall agreement to 67%. Within the textural classes, accuracy of field texture was the highest for sand, clay, sandy loam, and silt loam with the agreement being 74, 73, 68 and 63% respectively. The higher agreement of these textural classes is probably related to the ease of texturing categories where one soil separate dominates. As mixing of separates increases, the accuracy of field texturing decreases. Another factor which probably contributed to the higher accuracy is the greater area of the triangle covered by the clay, silt loam, and sandy loam classes.

A comparison of data from Pennsylvania, Minnesota, Maryland (different sampling dates), and those reported by Lakin and Shaw (1936) is

given in Table 2. With the exception of Lakin and Shaw's data, the overall accuracy of field textures from these sources is similar. Lakin and Shaw used an older version of the textural triangle and the conversion from centrifuge to pipette method of particle analysis for correlating field and laboratory textures at this time probably account in part for the lower accuracy. The weighted average of 50% accuracy of the 1739 samples appears to be representative of what can be expected for field determinations of textures. A wide variation exists, however, between the accuracy of the various textural classes.

Improving Accuracy of Field Textures

Several methods of improving the accuracy of field textures are available. Adequate training of personnel with standard samples of known texture is helpful. But probably of more benefit to the soil scientist in increasing his accuracy of textures is the availability of a laboratory to analyze questionable samples or even those which are generally thought to be accurate. Also, as more samples of various parent materials are run in the laboratory, the accuracy will be greatly increased. This is especially true in materials which can be easily characterized such as loess, coastal sediments, outwash, and certain glacial tills.

Revision of the textural triangle should be considered as one alternative in improving the accuracy of field textures. An important factor in any revision is to consider the general scatter of textures in sediments. The textural scatter of Coastal Plain soils, for example, falls conveniently into the present textural classes. One revision of the textural triangle used for the family classification in the 7th Approximation divides fine laomy and coarse loamy groups at 18% clay. This divi-

sion divides the cluster of points, especially in the loam and silt loam classes. Additional study of other sediments is needed to fully evaluate the consequence of this division.

Summary

The accuracy of over 600 field textures from Maryland was 50%; that is, in 50% of the cases, the field-textural class was in agreement with the laboratory results. The highest accuracy was found with sand, clay, sandy loam, and silt loam classes, with the agreement being 74, 73, 68, and 63% respectively. Errant field textures ware generally associated with high contents of coarse fragments, free iron, organic matter, and very fine or coarse sands.

It is realized that any major revision of the textural classification is a formidable task when considering the entire United States. The information collected in this study, although representing several major physiographic provinces, is meager. It does point out, however, weaknesses and strengths of the present classification. Before any drastic changes are made in the textural classification, it is recommended that a thorough study be made of the accuracy of field textures in other geographic areas, investigate the natural particle size distribution of other sediments, study the effect of the specific textural classes on soil-influenced processes, and then field testing the proposed system.

Table 1. Percentage agreement of field textures with laboratory analysis of soils sampled in Maryland.

Textural Class	Total No.	No. Correct	% Agree	No. within ± 4%	% Agree
Sand	27	20	74	24	89
Loamy Sand	40	14	35	29	73
Sandy Loam	87	59	68	72	83
Loam	98	35	36	57	58
Silt Loam	207	130	63	153	73
Silty Clay Loam	78	15	19	34	44
Clay Loam	28	5	18	13	46
Sandy Clay Loam	18	8	44	8	44
Silty Clay	8	3	38	3	38
Clay	15	11	73	12	80
Total	606	300	50	405	67

Table 2. Percentage of field textures from several sources agreeing with laboratory particle size analyses.

Textural Class	Md. 1966-70		Md. 1950-66		Penn. Data[1]		Minn. USDA No.9 (1966)		Lakin and Shaw(1936)		Summary[2]	
	Total No.	% Agree	Total No.	% Agree	Total No.	% Agree	Total No.	% Agree	Total No.	% Agree	Total No.	% Agree
Sand	12	92	16	69	7	43	71	93	20	80	106	86
Loamy Sand	22	45	14	43	46	50	13	31	33	18	95	44
Sandy Loam	57	74	42	69	118	64	27	78	72	51	244	68
Loam	50	38	65	35	102	76	15	42	24	12	232	54
Silt Loam	181	49	65	55	322	40	50	80	116	9	618	47
Silt	0	--	0	--	2	0	--	--	--	--	--	--
Silty Clay Loam	24	33	50	12	108	26	57	35	21	14	239	26
Clay Loam	17	6	15	53	21	14	25	60	26	4	78	35
Sandy Clay Loam	9	56	8	38	11	45	11	9	2	100	39	36
Sandy Clay	0	--	0	--	2	50	0	--	2	0	2	50
Silty Clay	2	100	5	40	46	24	12	0	7	0	65	42
Clay	11	91	5	40	15	53	4	75	20	95	35	66
Total No.	385		285		800		285		343		1739	
% Agree (Weighted Ave.)		51%		44%		45%		62%		29%		50%

[1]Penn. Data includes the following counties: Dauphin (Peterson, et al. 1968); Northampton (Cunningham et al. 1969); Huntingdon (Ranney, et al. 1970); Warren (Ciolkosz, 1970); and Washington, Venango, Schuylkill, Centre, and Lackawanna (Unpub.). Note: Additional data now available will change these values somewhat.

[2]Excludes Lakin and Shaw's data (Amer. Soil Surv. Assoc. 17:112-115).

Response of Corn to Various Tillage Practices

F. P. Miller
Department of Agronomy

Purpose and Objectives

With the advent of new equipment designs and new chemicals, farmers can widen their spectrum of seedbed preparation methods. The success of these techniques in corn production depends on many factors, not the least of which is climate, soil type, soil moisture at planting, and the influence of the soil-plant environment during growth.

The purpose of this study is to evaluate the response of corn to several methods of soil preparation and tillage. The tillage practices include subsoiling, plow-planting, disk-planting, deep-plowing, no-tillage, and conventional planting (plowing, disking, and planting).

Procedures

This study is located on the Bertie silt loam (somewhat poorly-drained) and the Mattapex silt loam (moderately well-drained soils. Four replications were used throughout and the plot size was 50 x 20 feet. The corn variety was XL66 planted in 30-inch rows on May 19. The no-tillage corn was planted with a modified four-row I.H. planter, and the conventionally planted corn utilized a four-row J.D. planter.

The cultivated plots were plowed and/or disked on May 12. The subsoiling was done on April 15 to a depth of 23 inches at three spacings; 22, 44, and 80 inches. The deep-plowing treatment was plowed to a depth of 12 inches.

Fertilizer was applied in accordance with soil test results with a yield goal of 150 bushels per acre. On May 12, prior to plowing, a broadcast application was made at the rate of 144-72-72 (lbs per acre of N-P_2O_5, K_2O).

A row application of 25-50-50 (lbs per acre of N-P_2O_5, K_2O), was made with the conventional planter. On the plots planted with the no-tillage planter, a topdressing at the rate of 20-40-40 (lbs per acre of N-P_2O_5, K_2O) was made. Thus, the total fertilizer application for the corn planted with the conventional equipment was 169-122-122 (lbs per acre of N-P_2O_5, K_2O) and the total for the no-tillage corn was 164-122-122 (lbs per acre of N-P_2O_5, K_2O).

A combination herbicide was applied to all plots on May 20 at the rate of one pound of atrazine (AATREX) and 1.5 pounds of alachlor (LASSO) per acre. The no-tillage plots had a very heavy infestation of chickweed which was sprayed three days ahead of planting with 1/4 pound (one pint) of paraquat per acre. The no-tillage corn was planted into the previous year's corn stover with no cover crop, other than the dense chickweed cover.

Results

The results for the 1970 subsoiling, deep-plowing and plow-plant treatments are presented in Table 1. The data also include the yields for the period 1967-1969.

Although the yields for the 44-inch (spacing) subsoiling treatment are significantly lower than the check treatment, there appears to be no trend when compared to previous year's data. The four-year average indicates that subsoiling these plots has provided no beneficial effect in terms of corn yield. In fact, there has been a trend toward a general yield reduction on these soils, possibly caused by additional equipment traffic resulting in compaction. The silty soils do not contain any kind of a pan or root restricting layer although they do crust badly when dry. Thus subsoiling these soils in the spring does not enhance corn production.

The deep-plowing treatment showed a 17-bushel per acre reduction in 1970 which was close to the significance level. However, the four-year average of 112 bu/A was not greatly different from the check. Likewise, the plow-planted treatment does not differ significantly from the check, although the trend toward blight yield reductions is noticeable.

The no-tillage treatment data are presented in Table 2. All plots were planted with the no-tillage planter, including the check-plot which was plowed and disked.

Statistical analysis showed the variance of the no-tillage from the check to be due to experimental error. Although a good stand of no-tillage corn resulted, there was a heavy infestation of fall panicum as the growing season progressed for both the no-tillage and disked-only plots. Despite this heavy infestation, the yields were not significantly different from the check. However, as a result of this problem, the herbicide combination of atrazine-simazine will be recommended since simazine appears to be more effective against fall panicum.

Table 3 contains soil temperature data under the no-tillage treatments, the soil temperatures under the chickweed mulch were as much as ten to 15 degrees lower than the check plots. Thus, even though there was no planted cover crop, the weed growth provided enough plant cover to alter the soil-root temperature region to a depth of at least five inches during the early growing season.

Table 4 contains soil test data samples at two-inch increments in the no-tillage and check plots on July 7. The P_2O_5 and the K_2O results were converted to ppm for purposes of expressing concentration rather than amounts since samples from only a two-inch section were taken.

The data indicate the fertilizer concentration at the surface of the no-tillage treatment since no mixing takes place within the plow layer. Except for the eight-inch segment, a steep nutrient gradient occurs within the plow layer of the no-tillage treatment whereas a more uniform mixing of nutrients is evident in the plow layer of the check plot. As the subsoil is encountered, both treatments indicate little nutrient movement downward, although years of liming and fertilization have resulted in some translocation of both lime (as indicated by pH) and fertilizer below the plow layer. It would be expected that if fertilizer application is continued on no-tillage corn, the surface pH could drop rapidly and a steep nutrient gradient could occur, especially for phosphorus. Work elsewhere (Shear and Moschler, 1969, Agron. Jour. pp. 524-527) has indicated that corn plants are able to feed equally well from surface-applied phosphorus or plowed-down phosphorus. This situation will continue to be monitored in the future.

Summary

After four years of subsoiling, no beneficial effects have been noted as measured by corn yields, regardless of the subsoil spacing. In fact, a trend toward yield reduction has been observed for each of the three subsoil spacings when compared to the check. Thus, on the soils studied, spring subsoiling is of no benefit and could even be detrimental to the physical rooting environment of corn.

Likewise, deep-plowing and plow-planting showed no increased yield over the check plot. However, in two out of three years, the plow-planted corn yielded almost as well as the check plot. Thus when considering time, labor, and money saved on the disking operation, this treatment on the soils studied should be considered on these merits. These treatments will continue to be evaluated in the future.

No-tillage corn production is possible on these soils. Problems with weed control and potential nutrient gradient difficulties must be monitored, however. After two years, corn yields have been equal to conventionally produced corn.

Table 1. Average corn yields for the period 1967-70 for five soil management treatments - Wye Institute, Maryland

Treatment	Average yield bu/Acre 1967	1968	1969	1970	4-year Average
Check	112	118	130	122	121
Subsoiled 80 inches	115	105	103	101	106
Subsoiled 44 inches	115	116	123	97	113
Subsoiled 22 inches	112	98	113	116	110
Deep-plowed (12 inches)	114	109	119	105	112
Plow-Planted	---	98	120	120	113 (3 years)

Table 2. Average corn yields for no-tillage treatment as compared to conventional - Wye Institute, Maryland

Treatment	Average yield bu/Acre 1969	1970
Check-Conventional	125	110
Disked only	131	120
No-tillage (no cover crop-chickweed, corn stover)	136	102

Table 3. The 1970 soil temperature data for no-tillage (rye) vs. conventional corn plots at several soil depths - Wye Institute, Maryland

Soil depth -inches-	June 3		June 19		July 7 [1]	
	No-tillage	Check	No-tillage	Check	No-tillage	Check
surface	78	92	85	94	84	83
1	76	81	83	91	82	81
2	74	77	81	87	80	79
3	71	73	78	81	78	76
4	--	--	76	78	--	--
Time	11:30 a.m.		12:30 p.m.		3:00 p.m.	
Sky	Clear		Clear-Hazy		Clear	
Air Temp.	84		91		95	

[1] The July 7 data were obtained under a 100% canopy cover by corn.

Table 4. Soil test results from no-tillage and check plots - Wye Institute, Maryland July 7, 1970.

Depth	Check			No-tillage		
	pH	P_2O_5	K_2O	pH	P_2O_5	K_2O
- inches -		-ppm-			-ppm-	
Surface	5.3	95	116	5.0	450	210
2	5.6	107	43	5.5	110	88
4	5.7	107	50	5.9	85	47
6	5.9	110	68	6.0	65	36
8	5.8	75	69	5.5	98	84
10	6.2	33	38	6.0	18	24
12	6.3	33	35	6.2	8	20
18	6.1	18	15	6.2	3	14
24	5.8	13	12	5.8	3	12

Effect of Fall and Spring Plowing on Soil Aggregate Stability and Corn Yield Under Various Cropping Systems

E. Strickling
Department of Agronomy

Purpose and Objectives

To determine the effect of fall and spring plowing for corn and soybeans on soil moisture, soil aggregate stability, and crop yield under various cropping systems.

Procedure

One-half of each corn plot in a cropping system experiment on Beltsville silt loam is plowed each fall and the remaining half is plowed in April. This experiment includes long and short rotations as well as continuous corn with a rye-vetch cover crop. Soil samples were taken for soil moisture and soil aggregation determination.

Results

The corn and soybean yields are presented in Tables 1 and 2. Yields previous to 1967 are presented for purpose of comparison although all plots were spring plowed during this period. Soil aggregation and soil moisture data are shown in Tables 3 and 4.

Summary

Fall plowing has had little effect on crop yield although soybean yields appear to have been depressed by fall plowing in 1967 and 1969. The 170 lbs. of nitrogen had about the same effect as 100 lbs. of nitrogen on all crops. Cropping systems have had large effects on corn and wheat yields. Aggregation was not effected by fall plowing but soil moisture was slightly higher in the spring plowed plots.

Table 1. Field Corn Yields in Cropping System Experiment.

Cropping System	Time of Plowing	1967		1968*		1969		1970		Av. 1967-70		Av.** 1959-66		Av. ** 1952-58
		100 N bu./A	170 N bu./A	100 N bu./A	170 N bu./A	100 N bu./A	170 N bu./A	100 N bu./A	170 N bu./A	100 N bu./A	170 N bu./A	100 N bu./A	170 N bu./A	100 N bu./A
Cont. C	Spring	134.0	140.6	25.8	30.2	117.0	110.8	87.8	87.5	91.1	92.3	53.6	61.9	72.6
	Fall	133.1	146.2	34.7	33.1	122.1	126.2	72.8	78.2	90.7	95.9	51.4	54.4	73.3
C$^{\square}$W	Spring	133.4	132.6	46.5	50.1	141.8	124.7	82.7	106.3	101.1	103.4	54.8	54.2	69.5
	Fall	132.4	137.1	38.7	37.2	129.2	121.5	94.6	98.0	98.7	98.5	51.9	51.9	75.6
CW	Spring	143.6	144.6	28.9	32.2	156.0	143.1	88.2	87.8	104.2	101.9	62.4	63.0	71.9
	Fall	145.1	146.8	41.3	40.7	141.4	147.7	97.3	89.1	106.3	106.1	64.0	61.2	70.8
CSW	Spring	155.8	151.6	41.4	49.9	148.9	135.8	91.6	108.2	109.4	111.4	62.7	62.1	73.4
	Fall	161.4	145.0	45.1	50.2	144.3	139.1	92.5	98.3	110.8	108.2	62.1	61.5	76.2
CWH	Spring	139.2	149.0	44.0	63.0	135.6	132.6	120.9	98.5	109.9	110.8	64.7	62.2	70.0
	Fall	142.0	153.3	63.1	63.2	137.3	146.5	113.6	96.8	114.0	115.0	66.9	65.5	76.1
CWHH	Spring	163.7	165.8	68.1	70.8	130.3	129.5	119.2	91.5	120.3	114.4	66.6	67.9	73.2
	Fall	169.9	165.4	73.4	74.5	141.6	138.7	135.0	93.9	130.0	118.1	66.5	69.2	79.6
CWPPP	Spring	156.8	169.4	54.1	60.6	126.0	146.7	111.2	142.6	112.0	129.8	69.6	71.4	72.6
	Fall	163.4	162.8	61.5	61.0	140.0	148.6	108.1	114.3	118.3	121.7	72.0	70.3	76.0
Av.	Spring	146.6	150.5	44.1	51.0	136.5	131.9	100.2	103.2	107.0	109.2	61.1	63.2	71.9
	Fall	149.6	150.9	51.1	51.4	136.6	138.3	102.0	95.5	109.8	109.0	62.1	62.0	75.4
	Av.	148.1	150.7	47.6	51.2	136.6	135.1	101.1	99.4	108.4	109.1	61.6	62.6	73.6

* Fall plowing was delayed until February by the weather.

** All plots were plowed about May 1 previous to 1967. A soil conditioner was applied in 1952 on all plots that were fall plowed starting with 1967.

*** C = corn, C$^{\square}$ = corn with stalks left on, W = wheat, H = alfalfa hay, P = ladino clover - orchard grass.

Table 2. Soybean Yields in Cropping System Experiment.

Cropping*** System	Time of Plowing	Year					
		1967 bu./A	1968* bu./A	1969 bu./A	1970 bu./A	1967-70 (Av.) bu./A	1952-66 (Av.) bu./A
Cont. soybeans (W, cover)	Spring	56.2	19.8	36.8	34.8	36.9	22.1
	Fall	53.8	20.2	24.7	38.4	34.3	23.2
C,S,W rotation	Spring	53.1	27.6	41.2	42.6	41.1	27.0
	Fall	47.5	31.7	37.1	39.3	38.9	27.1
Av.	Spring	54.6	23.7	39.0	38.7	38.8	24.5
	Fall	50.6	26.0	30.0	38.9	36.4	25.2
	Av.	52.6	24.8	34.9	38.8	37.8	24.8

* Fall plowing was delayed to February by weather.

** All plots were spring plowed from 1952 to 1966.

*** C = corn, S = soybeans, W = winter wheat.

Table 3. Soil Aggregation on Fall and Spring Plowed Plots in a Cropping System Experiment on Beltsville Silt Loam.

Cropping System*	Aggregation			
	July 27, 1970		Average 1967 - 1970	
	Fall Plowed %	Spring Plowed %	Fall Plowed %	Spring Plowed %
Cont. Corn* (stalks left Rye vetch cover)	11.3	15.5	12.5	15.4
Corn*, Wheat (stalks left)	21.7	23.3	20.1	20.3
Corn*, Wheat (stalks removed)	18.8	24.2	15.4	17.8
Sw. Corn*, Wheat	19.7	18.7	17.3	17.2
Corn*, Wheat, Hay	18.4	22.7	17.8	18.7
Corn*, Soybeans, Wheat	18.1	23.1	16.0	18.3
Corn*, Wheat, Hay, Hoy	19.3	20.0	21.4	22.3
Corn*, Wheat, 3 years Orchard Grass & Ladino Clover	42.8	44.5	33.9	35.0
Cont. Soybeans*	12.1	13.3	9.0	8.7
Soybeans*, Wheat, Corn	12.4	17.1	13.2	15.2
Cont. Fallow*	9.2	7.4	6.1	6.0
Average	18.6	20.9	16.6	17.8

* Sampled plots.

Table 4. Soil Moisture in the Plow Layer of Fall and Spring Plowed Plots in a Cropping System Experiment on Beltsville Silt Loam.

	Soil Moisture									
	5/13/69		6/10/69		6/8/70		7/20/70		Average	
	Fall Plowed %	Spring Plowed %	Fall Plowed %	Spring Plowed %	Fall Plowed %	Spring Plowed %	Fall Plowed %	Spring Plowed %	Fall Plowed %	Spring Plowed %
Cont. Corn (stalks left Rye vetch cover)	17.1	17.3	18.4	18.8	15.8	16.6	9.2	10.7	15.1	15.9
Corn, Wheat (stalks left)	17.8	18.4	17.7	18.5	16.0	16.3	9.2	10.0	15.2	15.8
Corn, Wheat (stalks removed)	16.4	17.2	19.0	19.3	16.0	17.0	9.7	10.2	15.3	15.9
Sw. Corn, Wheat	16.9	17.4	17.8	18.2	15.1	15.3	9.7	10.6	14.9	15.4
Corn, Wheat, Hay	17.1	17.2	17.8	18.7	17.4	17.1	9.8	10.3	15.5	15.8
Corn, Soybeans, Wheat	17.1	17.3	18.2	19.4	15.5	15.1	8.7	9.1	14.9	15.2
Corn, Wheat, Hay, Hay	17.9	19.1	19.6	20.1	16.3	16.0	9.6	9.0	15.9	16.1
Corn, Wheat, 3 years Orchard Grass & Ladino Clover	17.0	16.5	18.6	20.7	17.5	16.8	10.7	11.0	16.0	16.3
Cont. Soybeans	17.6	16.0	17.5	18.1	14.9	14.9	11.0	12.0	15.3	15.3
Soybeans, Wheat, Corn	16.9	17.4	18.2	18.3	14.8	16.2	11.9	11.6	15.5	15.9
Cont. Fallow	12.7	13.3	14.8	16.3	12.2	13.8	10.4	10.9	12.5	13.6
Average	16.8	17.0	18.0	18.7	15.6	15.9	9.9	10.5	15.0	15.6

Soil-Landscape Relationships in Southern Maryland

W. R. Wright and J. E. Foss
Department of Agronomy

Purpose and Objectives

Soil surveys have proven to be an invaluable tool for land use planning. Their value, however, is limited to the accuracy and detail at which soil maps are prepared. If soils can be related to their position on the landscape, mapping is simplified and the accuracy at which they can be delineated is enhanced. Therefore, the purpose of this study was to investigate the soil-landscape relationships on the upper Coastal Plain deposits in Southern Maryland.

Procedure

The field study consisted of a reconnaissance survey to observe clayey, upper Coastal Plain deposits; namely, Magnolia and Caroline soils, which had been previously mapped in Southern Maryland. Special attention was given to the areal distribution and geomorphic relationships of these soils. After numerous field observations, three landscape sites were selected for detailed study. A traverse was made at each site, in which soil cores were obtained at 25-foot intervals along a slope. Profile descriptions were made from each core and elevations were obtained at each interval with a surveyor's level.

Results

The physiographic features of Southern Maryland have developed largely in response to Pleistocene sea-level changes. Repeated steepening and flattening of stream gradients with concurrent formation and dissection of fluvial terraces have played a major role in shaping the present-day topography.

The greater part of Southern Maryland, in contract to the Eastern Shore, is a well-dissected upland area, declining in elevation from 400 feet in the vicinity of the "Fall Zone" to near sea level. At the higher elevations the stream valleys are commonly deep and narrow; however, as the elevations approach sea level, the valleys tend to broaden and become shallow with accompanying moderation of local relief.

The upper Coastal Plain deposits (> 100 foot elevation), also recognized as the "Sunderland" formation, were of particular interest in this study. These deposits, which range up to one-half miie across, occur in relatively flat areas between drainageways. The Beltsville, Magnolia, and Caroline soils dominate these interfluves, with Elkton soils occurring in the poorly-drained areas (Fig. 1).

Beltsville soils are moderately-well drained silty soils containing fragipans. They occur on relatively flat landscapes (0-5% slopes) and have developed only where the thickness of the silt mantle(loess ?) is greater than three feet. Approximately 25% of Charles County is mapped as Beltsville silt loam.

Magnolia and Caroline soils comprise only a small area in Southern Maryland, one and five percent,respectively. However, they have significant importance agriculturally and their geomorphic relations are quite unique. Magnolia soils occupy positions on the landscape which are similar to those of Beltsville soils; however, the silt mantle rarely exceeds 18 inches in thickness. Mangolia soils no not have fragipans and, although they are clayey in nature, they are well-drained.

Caroline soils usually occur on slopes ranging from five to ten percent. They are clayey soils and resemble the Magnolia soils both physically and chemically. Their morphological characteristics are

distinctly different, however. While the Magnolia is dark red (2.5YR 3/6) throughout the entire profile, the subsoil of the Caroline exhibits reticulate mottling. Although morphological characteristics indicate that Caroline soils are poorly drained, these mottles are believed to be relict features and thus, these soils are classified as well-drained. Water-table measurements have substantiated this anomaly.

As illustrated in figure 1, Caroline soils are found on back slopes bordering both Magnolia and Beltsville soils. Caroline type material (clayey, reticulate mottling) is also frequently found underlying Beltsville soils and occasionally under Magnolia soils in the transition zone.

Elkton soils dominate the low-lying areas between interfluves and comprise nearly five percent of Charles County. These poorly-drained soils have silt loam surfaces and clayey subsoils similar to those of Magnolia and Caroline soils. Therefore, it is believed that Magnolia, Caroline, and Elkton soils comprise what might be termed a paleo-catena.

Basal gravels are exposed on slopes of the upper Coastal Plain where severe erosion has occurred. Soil developed on these deposits are classified as Aura soils and comprise approximately five percent of the land area in Charles County. They generally occur on slopes in excess of ten percent and their position on the landscape is illustrated in figure 1.

Summary

Soil-landscape relationships were investigated on the upper Coastal Plain sediments in Southern Maryland. Reconnaissance surveys and detailed analyses of slopes and profiles revealed that definite relationships exist. These relationships are:

1. Beltsville and Magnolia soils occur on similar geomorphic positions, viz., interfluves. However, Beltsville soils only occur where the thickness of the silt mantle(loess?) is at least three feet.
2. Caroline soils, which exhibit relict mottles, are located on back slopes (5-10% slope) bordering both Beltsville and Magnolia soils.
3. Poorly-drained Elkton soils occur in the drainageways between interfluves.
4. Aura soils are found where severe erosion has occurred and basal gravels are exposed.
5. The Magnolia, Caroline, and Elkton soils comprise what might be termed a paleo-catena.

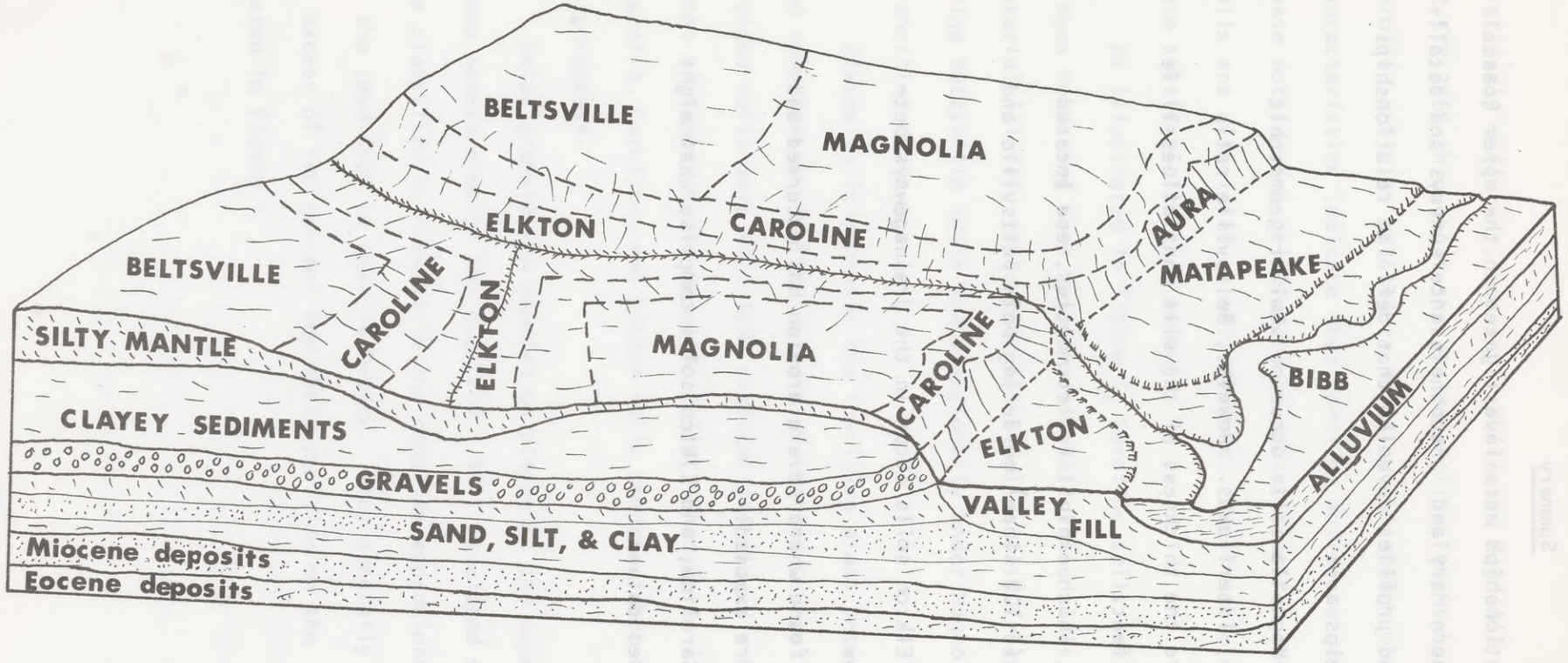

Figure 1. Schematic representation of soil-landscape relationships in Southern Maryland